A FIELD GUIDE TO TROPICAL AGRICULTURE

FOR

THE UNION OF BURMA

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By

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in Tropical America, Spain and Burma.

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FOREWORD

This handbook is a compilation of agricultural information from every readily available source. Well tempered by the wide, scientific and practical background of the author, the handbook presents a concise statement of theory and practice in the broad field of tropical agriculture and endeavors to be brief but specific in the areas where preciseness is needed.

The composition of this book has been directed toward simplicity. Many of the more common problems have been reduced to their simplest form through the use of tables and charts, the use of which will in many instances enable the reader to solve his problems quickly with a minimum of reading and at the same time obviate the necessity for making many tedious calculations.

When one considers the numerous volumes that have been written in this field and when he realizes that entire encyclopedias have been devoted to the task of exhausting the subject, one wonders how another publication can be helpful. The present handbook, however, differs in that it is just what its title implies, i.e., a concise field manual with readily available information for the tropical agriculturist. It is a quick guide to be carried into the field for immediate reference, to answer on-the-spot questions which cannot wait for future study or decisions.

The handbook has been prepared to this end and it is hoped that it will fill the need for which it was intended.

DONALD P. BARNES
AID Representative.

PART I

BASIC AGRICULTURAL INFORMATION

CHAPTER I

Standardization

Trading in Tropical Agricultural produce as a whole must be described as being almost devoid of standards. Quantities are not standardized: qualities are not standardized nor are the methods of handling and transport standardized. Everybody handling produce from the fields runs risks, risks which are often quite unnecessary but for which, so long as they exist, the risk bearer must exact his toll. Costs of handling are high in consequence.

Standardization of Weights and Measures

The system of weights and measures, generally used outside the larger towns in most tropical areas is chaotic. The capacity of the measures in use will vary from crop to crop and station to station An excellent example of this is the basket used for measuring paddy or beans in Burma. The tilseed basket used at one center may differ in volume from that in use at another center only a few miles away. Even at the same center and for the same commodity the volume may vary from individual to individual or from transaction to transaction Indeed the choosing of the basket to be used is a frequent preliminary to any bargaining as to price.

As regards weighing standards, the situation is little better and prices have no exact meaning, and where prices have no exact meaning the one

incentive which can foster grading for quality is missing. Buying and selling thus becomes something of a gamble in which the buyer pits his skill in manipulating quantities against that of the seller in adulterating down to the limit of acceptance. Produce so handled not only fails to command its full price at the primary point but is often rendered quite unfit for any subsequent grading action.

Figuring is not a strong point with the cultivator and the calculations necessary to link variation in quantity with its corresponding variation in price is usually beyond him. Thus he falls an easy victim to the sharp practices of those to whom buying and calculating are a matter of day to day routine.

Thus a safety for the selling cultivator lies only in anchoring himself to a standard unit of weight or measurement. Since in the village there is no "standard" the first step lies in the introduction of a system of standardization and it is here suggested that the metric system or local standards tied to metric equivalents be adopted for all countries.

Quality Standardization: That there is need for work in this direction is shown by the constant complaint in foreign trade that goods from tropical areas cannot be relied upon. This complaint is not always justifiable and one must acknowledge that goods can be and are found which are of consistent quality. Unfortunately in most countries these are the exception and not the rule. As a result, buying is done under a cloud of suspicion, a suspicion which carries with it as corollary a reduced price by way of safeguard. Retaliations which result give further cause for suspicion and dissipate energy on the part

of both buyer and seller which might be put to more profitable use. Adherence to standards offers the only way of escape from this. For example, in the rice trade of Burma, the industry which has reached the highest degree of development in the country, quality grading and standardization cannot as yet be considered as perfect. For all other crops there is at present practically no fixed grades or qualities.

Measuring Units of Various Tropical Countries

(Weights)

BURMA

100 ticals = 1 viss = 3.64 lbs.
1 basket — paddy = 46 lbs.
1 bag — paddy = 160 lbs.

INDIA

1 tola is the weight of one rupia (0.414 oz) or (11.6 gr.)
10 tolas = 1 chittack (4 oz) = 116 grams
8 chittacks = 1 seer (2.06 lbs.) = (933 grams)
40 seers = 1 maund (82.3 lbs.) = 37.3 kg.

MALAYA

1 tahil = 1.33 oz = 0.083 lbs. = 0.036 kg
16 tahils = 1 katti = 1.33 lbs. = 0.60 kg.
100 katti = 1 pikul = 133.3 lbs. = 60.4 kgs.
3 pikul = 1 bhara = 400 lbs. = 181.2 kgs.
40 pikul = 1 koyan = 5333.3 lbs. = 2417 kgs.

SOUTH AMERICA

40 granos = 1 adarme = 1/16 oz.
16 adarmes = 1 oz.
16 onza = 1 lb.
25 libras = 1 arroba.
4 arrobas = 1 quintal = 100 lbs.
20 quintals = 1 tonelada = 2,000 lbs.
1 carga = 2 quintals or 200 lbs. of coffee.
1 tonelada = 1000 kilograms = 2,240 lbs.

AFRICA

(SWAHILI)

16 wakia = 1 ratili = 1 lb.
3 ratel = 1 mani = 3 lbs.
6 ratel = 1 pishi = 6 lbs.
6 pishi = 1 frasila=36 lbs. (35 lbs. Zanzibar)
8 frasila = 1 gisla = 288 lbs.
10 frasila = 1 mzo = 360 lbs.
63 frasila = 1 tonelada = 2,000 lbs.
64 frasila = 1 tonelada (Zanzibar).

CEYLON

1 candy = 560 lbs = 253.7 kg.

EGYPT

1 rotl = .99 lbs = .448 kg.
1 kantar = 100 rotls = 99.05 lbs = 44.9 kg.

TRINIDAD

1 Fanega = 110 lbs = 49.83 kg.

(Linear)

SOUTH AMERICA

10 lineas = 1 inch.
10 inches = 1 cuarta.
4 cuartas = 1 vara = 40 inches.
100 varas = 1 cuarda = 4,000 inches.
62.5 cuadras = 1 legua = 5,000 meters.

MALAYA

2 jenka = 1 hasta = 18 inches.
2 hastas = 1 ela = 36 inches.
2 ela = 1 depa = 72 inches.
2 depa = 1 jemba = 144 inches.

AFRICA

(SWAHILI)

1 wanda = 1 inch
8 to 10 nyanda = ¼ yard (approx) = 1 shir
2 shiribi = 1 mkono = 1 codo = ½ yd.
2 thiraa = 1 wasi = 1 yd.
2 wasi = 1 pima = 2 yards.

(Surface)

MALAYA

2 depa (sq) = 1 jemba (sq) = 144 sqft.
400 jemba (sq) = 1 1/3 acres (approx.)
100 ,, (,,) = 1 penjuru = 14,400 sqft.
4 penjuru = 1 orlong = 57,606 sqft.

SOUTH AMERICA

64.000 sq meters = 1 cuadra
,, ,, ,, = 1 fanegada
,, ,, ,, = 1 plaza

INDIA

1 bigha = 0.33 acres.

SOUTH AFRICA

1 morgen=2.12 acres=0.85 Has.

EGYPT

1 feddan = 1.04 acres = 0·42 Has.

TRINIDAD

1 carree = 3.2 acres = 1.29 Has

INDONESIA

1 bouw = 1.75 acres = 0.71 Has.

Useful Standards

Unlike most books which relegate their short-cut methods to the back page, this manual presents its useful tables and measures in the most prominent and readily accessible position in the book. The agriculturist need not feel apologetic for relying on this ready form of calculation because farming, as such, is not an exact or precise science and simplification is the answer to rapid progress.

Weights and Measures

Imperial Longitude

12 inches ( ) = 1 foot ( )
3 feet = 1 yard (yd)
5½ yards = 1 rod
40 rods = 220 yards = 1 furlong
8 furlongs = 1 mile = 5280 feet

Metric Longitude

10 microns (u = 1 millimeter (mm)
10 millimeters = 1 centimeter (cm)
10 centimeters = 1 decimeter (dm)
10 decimeters = 1 meter (m)

1000 meters = 1 kilometer (km)

Conversions (Metric to Imperial)

1 centimeter = 0.39 inches (approx)
5 centimeter = 2 inches (approx)
1 meter = 39.37 inches or 3.23 feet (approx 1 yd)
1 kilometer = .062 miles

Imperial Surface

144 square inches = 1 square foot
9 square feet = 1 square yard
30¼ square yards = 1 square rod
40 square rods = 1 rood
4 roods = 1 acre
640 acres = 1 square mile (6.272,640 square inches)
43560 square feet = 1 acre
4840 square yards = 1 acre

Metric Surface

100 square centimeters = 1 square decimeter
100 square decimeters = 1 square meter (10,000 sq. cent.)
10.000 square meters = 1 hectare

Conversion Metric to Imperial

1 square centimeter = 0.155 sq. inches
1 square meter = 10.76 square feet or 1.196 yards
1 hectare = 2.47 acres
1 square kilometer = 0.386 sq. miles

Imperial Capacity

5 fluid ounces = 1 gill (4 fl. oz. US)
4 gills = 1 pint (pt)
2 pints = 1 quart (qt)
4 quarts = 1 gallon (gal)
2 gallons = 1 peck (pk)
4 pecks = 1 bushel (bu)
8 bushels = 1 quarter (qr)

One gallon of water contains 277.42 cubic inches (0.16 cu. ft) and weighs 10 lbs at 20°C.

6.25 gallons = 1 cubic foot or 1000 ounces
1 bushel = 1.28 cubic feet = 8 gallons
1 fluid ounce of water weighs = 1 oz
1 pint of water = 1¼ pounds
1 gallon of water = 10 pounds at 20°C.

Metric Capacity

10 milliliters = 1 centiliter = 0.070 gills
10 centiliters = 1 deciliter = 0.176 pints
10 deciliters = 1 liter = 1.760 pints
1 cubic centimeter (water) = 1 gram
1 liter of water = 1000 grams (1 kilogram) 2.2 lbs

Imperial Weight (Avoirdupois)

27.34 grains = 1 dram
16 drams = 1 ounce
16 ounces = 7000 grains = 1 pound
14 pounds = 1 stone
28 pounds = 1 quarter
2000 pounds = 1 ton (short)
2240 pounds = 1 imp. long ton

Metric Weight

10 milligrams = 1 centigram
10 centigrams = 1 decigram
10 decigrams = 1 gram
1000 grams = 1 kilogram
1 kilogram = 2.20 lbs (avoirdupois)
100 kilograms = 220.46 lbs ,,
1000 kilograms = 1 metric ton = 2,204.6 lbs

Temperature Conversion

$$°F = \frac{°C \times 9}{5} + 32 \qquad °C = \frac{(°F - 32) \times 5}{9}$$

Freezing Point = F 32° C 0°
Boiling Point = F 212° C 100°
N. Body Temp. = F 98.4° C 37° (livestock)

Useful Conversion Factors

Feet to meters = 0.30	Inverse	=	3.28
Yards to meters = 0.91	,,	=	1.09
Inches to millimeters = 25.40	Inverse	=	0.04
Miles to kilometers = 1. 61	,,	=	0.62
Sq. miles to acres = 640.0	,,	=	.0016
Acres to hectares = 0.40	,,	=	2.47
Cubic inches to bushels = 0.00045	,,	=	2219.30
Cubic feet to gallons = 6.23	,,	=	0.160
Gallons to liters = 4.55	,,	=	0.22
Cubic feet to liters = 28.32	,,	=	0.0353
Pounds to kilograms = 0.45	,,	=	2.205
Ounces to grams = 28.35	,,	=	0.0351
Pounds of water to cubic inches		=	27.683
	Inverse	=	0.036
Kilograms per hectare to pounds per acre		=	0.89
	Inverse	=	1.12

Crop Labor Requirements

In order to prevent repetition in later discussions, basic information needed for conversions and interpretations are recorded in this first chapter and may be referred to easily as needed. As an introduction to some of the more essential tables, there follows a series of paragraphs which outline the expected work load from hand labor on the farm. Since it would be impossible to give similar data for all operations, only the most important ones have been selected. From these data and prevailing wage rates costs per acre can be roughly calculated.

Manure Spreading — One man, and one oxcart with a capacity of 1,200 pounds, can without assistance, deliver and spread in 10 hours five loads daily if each entire round trip is not over one half mile. If it requires a maximum of 15 tons per acre, one man could deliver and spread manure sufficient for 1/5 of an acre. One man with a loader tractor and 2 ton manure spreader will spread about 3 acres of manure daily.

Brush Clearing — Average brush requires one man with hand blade working 10 hours to clear 10,000 square feet or approximately 1/4 of an acre (about 4 man days per acre). This can be done with machinery and one man's time at the rate of one acre per hour.

Excavation — One man can dig an area 250 to 300 square yards 8 inches deep in one day. At this rate 10 to 20 men would be required to dig one acre to the same depth.

Drainage — One man can dig a ditch 200 to 300

feet in length in one day if the soil is light and the ditch is no more than 2 feet wide and one foot deep.

Row Cultivation — One man with single ox and cultivator can cultivate 1½ acres daily if the rows are no farther than 2½ feet apart. A horse or mule will do two acres and a tractor with 2 row cultivators will do 40 acres daily.

Post Setting — One man can set 30 to 50, six inch posts two feet deep in one day.

Plowing — One team of oxen ploughing a 6 inch furrow can plow one half acre per day. A team of horses or mules will plow one acre in one day and a light farm tractor with one plough will complete about 10 to 15 acres.

Planting and Harvesting — Cacao — 3 men can pick and open 300 pounds of pods daily and clean culture requires another 3 men to remove weeds from one acre in one day.

Coco — 4 men working together should harvest and extract the meat from 2,000 to 3,000 coconuts per day.

Citrus — One man can *pick* 10 baskets of oranges daily (200 oranges per basket) or shake harvest 20 baskets.

Forage — One man (hand cutting) can harvest 10,000 square feet of elephant grass in one day (about 1/5 of an acre). One man can hand plant sprigs of pasture grass at the rate of 1,000 sq. ft per day (sprigs 8" x 8" apart).

Corn — One man can seed one acre of corn in 3 days by hand (plantings 3' x 1'). To fertilize one acre of corn with 350 pounds of fertilizer requires one man one day. One man can pick and husk 600 pounds of ear corn in one day or about 3 acres.

Rice — 10 men can transplant one acre of placed seedlings in one day, (settings 15 inches x 15 inches). 10 men can harvest one acre of (3,000 pound yield) rice in one day. One man can husk 16 pounds of rice by hand in one day, but it takes one man one day to load, thresh and sack 50 pounds of rice ready for husking.

Sugar cane — One man can cut 2,500 stalks in one day (or about 3 tons).

Cotton — Cotton in fields yielding ½ bale or less to the acre can be picked by one man at the rate of 70 to 100 pounds per day. High yielding cotton can be picked at the rate of 200 pounds per man per day. (Asiatic cotton much less).

Chili — One man can pick 80 to 100 pounds per day.

Coffee — One man can pick 100 to 250 pounds of cherries daily depending on the yield.

Cow Peas — 5 acres of hand harvested cow peas yielding 350 pounds per acre require 6 to 8 men for one day.

Fibers — One man day is required to wash 30 pounds of dry fiber after it has been retted.

Groundnuts — 2 men can harvest 70 lbs. of nuts or ½ of an acre in one day.

Rubber — One man can tap 200 to 300 trees daily.

Roots & Tubers —One man can dig 200 square yards (0.4 acres) and harvest 500 lbs. of tubers in one day. It requires 8 men to plant an acre in tubers.

Vegetables — Vegetables such as tomatoes and lettuce can be planted at the rate of 2,500 per day by one man (this quantity covers about 0.4 of an acre). Most field planted seeds such as corn, beans, etc. can be planted at the rate of 0.2 to 0.3 acres per day by one man. For setting stakes and tying plants to stakes it requires one-man day to place 600 stakes and one-man day to tie 90 plants to 90 stakes. Tomatoes and similar crops are harvested at the rate of 300 pounds daily per man.

Man-Days Labor Required For Selected Crops

Crop	Man-Days Per Acre
Cotton	122
Sweet Potatoes	115
Groundnuts	108
Cassava	100
Established Coffee	100
Maize	80
Beans	80
Sesame	75
Eleusine Millet	72
Opening up new grassland	80

Tabular Guides For Crop And Animal Culture

Following are a series of tables designed for

dispensing crop and animal information in a readily available form. Details of course may be found in the text. In the field the need for making rapid decisions makes the need for rapidly available information indispensable and agricultural operations have no time allotted for indecision or library research. This chapter therefore is intended to fill the need for rapidly available information needed for on-the-spot decisions. It still is not so complete as could be wished for but it can be expanded by the individual or some future compiler.

Spacing, planting depth, seed requirements, time required for maturity, and estimated yield of vegetables in the Tropics.

Crop	Spacing of plants		Depth to plant seed	Quantity of seed or plants per 25-ft. row	Time required to reach maturity	Estimated yield per 25-ft. row
	In row	Between rows				
	Inches	Inches	Inches		Days	
Asparagus *	18-24	36	¾—1	12—16 plants	730	2 pounds
Bean, green bush	3-6	18-24	¾—1½	4 ounces	42— 56	12 pounds
Bean, lima bush	6-8	18-24	¾—1½	3 ounces	60— 80	6 pounds
Beet	2-3	18-24	½—1	½ ounce	65—100	20 pounds
Broccoli	15-18	18-30	½	12—15 plants	65— 85	8 pounds
Brussels sprouts *	15-24	18-30	½	12—15 plants	120	2 pounds
Cabbage	12-24	18-24	½	12—25 plants	70—100	12—25 heads
Cabbage, Chinese	8-16	15-24	½	1 packet	95—100	18—30 heads
Carrot	2-3	15-18	½	½ ounce	74—108	20 pounds
Cauliflower	15-18	24-30	½	16—20 plants	56—118	16—20 heads
Celery *	6-12	15-24	1/3—½	25—50 plants	110—150	25—50 heads
Chard, Swiss	6-12	15-24	¾—1	1 packet	60— 75	25 pounds
Collard	15-18	18-24	½	12—15 plants	80—100	30 pounds
Corn, sweet	10-15	24-36	2—3	2 ounces	90—120	30 ears
Cucumber	36-48	48-60	½	½ ounce	56— 65	15 pounds
Eggplant	24-36	30-36	½	8—12 plants	89—132	50 pounds

Spacing, planting depth, seed requirements, time required for maturity, and estimated yield of vegetables in the Tropics (*Continued*)

Crop	Spacing of plants		Depth to plant seed	Quantity of seed or plants per 25-ft. row	Time required to reach maturity	Estimated yield per 25-ft row
	In row	Between rows				
	Inches	Inches	Inches		Days	
Endive	12-15	15-18	½	⅓ ounce	56—92	12 pounds
Kale	18-24	12-15	½—1	do	52—91	15 pounds
Kohlrabi	18-24	3-6	½—1	1 packet	50—98	do
Leek	15-18	2-3	½	do	132-160	
Lettuce, leaf	8-12	6-12	½—¾	do	46—70	25—30 bunches
Mustard	1-2	18-24	½	do	48—59	25 pounds
Okra	12-15	36-48	½	¼ ounce	55—60	30—40 pounds
Onion, green	4-6	18-24	½	1 packet	120	10 pounds
Parsley	4-6	12-18	½	do	75	5 pounds
Parsnip *	4-5	15-18	½	do	139	24 pounds
Pea	2-6	13-24	1—1½	2— 4 ounces	57—78	5 pounds
Pepper	12-18	18-24	½	16—25 plants	96-112	15 pounds
Potato	12-15	18-24	3—4	20—25 seed pieces	75-100	20 pounds
Pumpkin	72-84	72-84	½	½ ounce	112	30—40 pounds
Radish	1-2	12-18	½	do	23—30	20 dozen
Rhubarb *	24-36	24-36	½	12—16 plants	132	

Spacing, planting depth, seed requirements, time required for maturity, and estimated yield of vegetables in the Tropics (*Continued*)

Crop	Spacing of plants		Depth to plant seed	Quanity of seed or plants per 25-ft. row	Time required to reach maturity	Estimated yield per 25-ft. row
	In row	Between rows				
	Inches	Inches	Inches		Days	
Rutabaga	3—6	18—24	½	1 packet	72	15 pounds
Spinach, New Zealand	12—15	18—24	½	2 ounces	63—76	10 pounds
Squash	36—48	36—48	1—1½	1 ounce	47—89	25—40 pounds
Tomato	24—48	36—48	½	6—12 plants	54—90	50 pounds
Turnip	3—6	15—24	1—1½	1 packet	70—75	10 pounds
Watermelon	36—48	48—72	1—2	½ ounce	100	100 pounds

* Grown with difficulty in hot humid areas.

A Planting Guide To The Better Tropical Pasture Grasses

Tribe	Species	Common name	Natural Habitat	Habit of growth	Palatability	Nutritive value	Planting method & rate
Agrosteae	Agrostis spp.	Bent Grass	Arid Sandy Tropics	Tufted	Poor	Low	Seed 10 lbs. per acre
Andropogoneae	Andropogon gayanus	Gamba Grass	Wide range of soil types; long dry season	Erect, tufted to 6 ft.	Good when young but flowering culms unpalatable	Moderate	Normally from seed but supply limited.
	Bothriochloa insculpta	Sweet-pitted grass	Low to medium rainfall; 3000 to 6000 ft.	Tufted to 3 ft; weakly stoloniferous; turf-forming when grazed	Good	Moderate	Seed; supply limited.
	Sorghum sudanense	Sudan grass	Moderate summer rainfall; wide range of soils	Tufted, erect, heavy tillering; annual to 12 ft.	Good; sugar content high	Good, but some danger of prussic-acid poisoning when very young	From seed
	Sorghum halepense	Johnson Grass	Temperate to Tropic	Rhizomatous-erect growth	Excellent	High	Seed 15 lbs. per acre.

Tribe	Species	Common name	Natural Habitat	Habit of growth	Palat-ability	Nutritive value	Planting method & rate
	Sorghum almum	Colombus Grass	Moderate summer rainfall; wide range of soils; sub-tropics	Tufted, erect to 12 ft., short, thick rhizomes	Good	Good but some danger of prussic acid poisoning	From seed which is readily available.
Chloridcae	Chloris gayana	Rhodes Grass	Over 2,000 ft. Up to 50 in. summer rainfall	Stoloniferous, turf-forming; erect to 4 ft.	Very good even when dry	Moderate; leaf/stem ratio falls rapidly with age	Normally by seed
	Cynodon dactylon	Bahama Grass, Bermuda grass Star grass Doob grass	Sea level to 5,000 ft. Dry to medium rainfall Prefers a high pH	Rhizomatous and stoloniferous; open sward to 12 in.	Good	Fair. Great range in leaf/stem ratio according to selections	Seed available for lawns; Sprigs and runners for pasture.
	Cynodon plectostachyus	Giant Star Grass, Naivasha Star grass	Sea level to 5,000 ft. Drier than for C. dactylon	Rapidly spreading stoloniferous; trailing stems to 3 ft.	Good, particularly during the dry season	Above average	Vegetatively by rooted sets or runners. Seed limited.

Tribe	Species	Common name	Natural Habitat	Habit of growth	Palatability	Nutritive value	Planting method
Eragrost-eae	Eragrostis curvula	Weeping love grass	Semi-arid tropics and sub-tropics, summer rainfall	Tufted; long spreading narrow leaves to 3 ft.	Poor to fair	Low	From seed.
Oryzeae	Loersia hexandra	Rico grass	Humid Tropics (swampy)	Upright, tufted.	Good	Fair	
Paniceae	Acroceras macrum	Nyle grass	Medium rainfall poor drainage	Erect, somewhat sparse stand from slender rhizomes	Good	Fairly high	Root division or rhizome
Paniceae	Axonopus compressus	Savannah grass Carpet grass	Well distributed medium to heavy rainfall; alluvial soils. Sea level to 2000 ft.	Short, dense turf to 18 in; rapidly spreading stolons	Good when young	Fairly high when young	Root division
	Digitaria decumbens	Pangola grass	Dry, alluvial sub-tropical areas to moist, well drained full tropics. Sea level 5000 ft.	Dense trailing mat to 2 ft.; vigorously stoloniferous	Very good for considerable period of growth	Generally high when young, failing somewhat at maturity	Root division or stem lengths disced-in

Tribe	Species	Common name	Natural Habitat	Habit of growth	Palat-ability	Nutritive value	Planting method
Paniceae	Echinochloa pyramidalis	Antelope grass	Heavy soil, seasonal swamp, low to medium altitude	Tall tufted robust to 15 ft. rhizomatous	Very good	Good; low fiber content	Root division; limited amount of viable seed produced
	Eriochloa polystachya	Carib grass Malojilla grass	Sea level to 3,000 ft; moist medium-heavy soil	Fine stemmed; trailing from decumbent stems to 4 ft.	Good	Good	Root division or disced-in stem lengths
	Melinis minutiflora	Molasses grass	Well drained soil, moderate rainfall	Trailing to decumbent stems	Very good when cattle are accustomed to it.	Good	Perennial Drouth resistant Stem cutting & roots
	Panicum antidotale	Blue Panic grass	Low altitude, light soils, low-mediumsummer rainfall	Densely tufted to 6 ft: rhizomatous	Fair, only when young	Fair only	Rooted cuttings or seed

Tribe	Species	Common name	Natural Habitat	Habit of growth	Palat-ability	Nutritive value	Planting method
Paniceae	Panicum coloratum var. Makarakariense	Makarakari grass Colored guinea grass	Low summer rainfall; deep alluvial soil	Variable; erect to spreading from decumbent stolons	Good	Good	Stem cuttings or seed, quality of which varies with the ecotype
	Panicum maximum	Guinea grass	Low to medium rainfall; well drained soils, Sea level to 4000 ft.	Tufted to 6 ft.	Good, particularly when young	Good but falls rapidly with age	Root division or encouragement of self seeding
	Paspalum dilatatum	Dallis grass	Humid subtropics heavier soils; low altitude	Strongly tufted, deep rooted, slow lateral spread; culms to 5 ft.	Very good	Moderately good	Commercial seed available but establishment low
	Paspalum notatum	Bahia grass	Light well-drained soil; medium to high rainfall. Sea level to 5000 ft	Low growing, stiff dense cover from short shallow rhizomes; up to 18 in.	Rather low, improved by breeding	Moderately good	Root division for soil conversion work, seed of improved varieties for pasturage.

Tribe	Species	Common name	Natural Habitat	Habit of growth	Palat-ability	Nutritive value	Planting method & rate
Paniceae	Pennisetum clandestinum	Kikuyu grass	Fertile, well-drained soil; Medium rainfall.	Low growing, deep rooting, rhizomatous and stoloniferous	Good	Good	Vegetatively from cuttings or runners
	Pennisetum purpureum	Elephant Grass Napier grass Merker grass Uganda grass	Medium rainfall; heavier well-drained soil: Sea level to 5,000 ft.	Giant tufted grass up to 20 ft; limited spread from short rhizomes; deep-rooted	Very good when young and leafy	Good	Stem cuttings or whole lengths buried in furrow
	Setaria sphacelata	Golden timothy grass	Low to medium rainfall. Sea level to 7,000 ft	Tufted to decumbent and stoloniferous; very variable	Good	Good	Seed readily available and establishment fairly rapid
Tripsaceas	Tripsacum laxum	Guatemala grass	Humid Tropics	Cut forage only, vigorous growth	Excellent	High	Cuttings

A Planting Guide to the More Important Horticultural Crops

Crop	Latin Name	Habitat	Culture	Per Acre yield
Avacado Pear	Persea gratissima	Sub-Tropical	Seed/layers 25 x25	400 fruits
Banana	Musa cultivara	Humid Tropics	Sucker 12'x12	6 Tons
Cacao	Theobroma cacao	Humid Tropics	Cuttings or Seed 12 x12	400 lbs
Coconut	Cocos nucifera	Humid Tropics	Seed 30 x30	2500 nuts
Coffee	Caffea arabica	Humid Tropics	Seed 8 x8	600 lbs
Coffee	Caffea canephora	Humid Tropics	Seed 15 x15	1200 lbs
Lemon	Citrus limonea	Tropic/to/ sub.	Grafts 15 x15	500 fruits
Mango	Mangifera indica	Tropical	Grafts 15 x30	—
Oil Palm	Elaeis guineensis	Humid Tropics	Seed 25 x25	4½ tons
Orange	Citrus sinensis	Tropic/to/ sub.	Grafts 20'x20	750 fruits
Papaya	Carica papaya	Tropical	Seed 8 x8	50 fruits
Pine-apple	Ananas sativus	Sub-humid Tropics	Suckers 5'x2	5 tons
Rubber	Hevea brazilensis	Humid Tropics	Seed 20 x20	100 lbs
Tea	Camellia sinensis	High Altitude Humid-Tropical	Seed 4'x4'	700 lbs

A Planting Guide to the More Important Edible Field Crops

Crop	Name	Habitat	Seed rate per acre	Spacing ft.	Per Acre Yield
		Cereals			
Maize	Zea mays	Temperate to Tropical	5-20 lbs	3 x 1	2500 lbs
Millet barn	Echinochloa frumentacea	Swampy Tropical	10 lbs	broadcast	400 lbs
Millet panicum	Panicum miliaceum	Tropical	10 lbs	broadcast	800 lbs
Rice	Oryza sativa	Humid Tropics	50 lbs	1½ x ½	4000 lbs
Sorghum	Sorghum vulgare	Temperate to Tropical	50 lbs	3 x 1	1500 lbs
		Legumes			
Bean kidney	Phaseolus vulgaris	Temperate to Tropical	30 lbs	½ x 1	800 lbs
Bean lima	Phaseolus lunatus	Temperate to Tropical	30 lbs	½ x 1	1200 lbs
Bean soy	Glycine max	Temperate to Tropical	30 lbs	1 x 1	1200 lbs
Bean lablab	Dolichos lablab	Temperate to Tropical	40 lbs	broadcast	400 lbs
Pea garbanzo	Cicer arietinum	Temperate to Tropical	40 lbs	2 x 2	600 lbs
Pea cow	Vigna sinensis	Temperate to Tropical	20 lbs	2 x 3	600 lbs
Pea pigeon	Cajanus cajans	Tropical	20 lbs	4 x 5	1000 lbs

Crop	Name	Habitat	Seed rate per acre	Spacing ft.	Per Acre Yield
		Legumes (*Continued*)			
Pea groundnut	Arachis hypogaea	Temperate to Tropical	50 lbs	1½ x 1	1500 lbs
Pea lentil	Lens esculenta	Temperate to Tropical	30 lbs	broadcast	400 lbs
		Roots			
Aruzruz	Maranta arundinacea	Tropical	rhizome	3 x 1	2 tons
Cassava	Manihot esculenta	Tropical	cutting	4 x 4	10 tons
Canna	Canna edulis	Tropical	rhizome	3 x 3	1 ton
Dasheen	Colocasia esculenta	Humid Tropics	corm	3 x 3	5 tons
Name	Dioscorea esculenta	Tropical	tuber	3 x 3	1 ton
Sweet Potato	Ipomoea Batatas	Temperate to Tropical	slips	2 x 3	4 tons
Tannia	Xanthosoma sagittaefolium	Tropical	rhizome	3 x 3	15 tons
Topee	Calathea allouya	Tropical	tuber	2 x 1½	4 tons
Yam	Dioscorea alata	Tropical	tuber	3 x 6	2 tons

Crop	Name	Habitat	Seed rate per acre	Spacing ft.	Per Acre Yield
		Fibers			
Abaca	Musa textilis	Humid Tropics	Suckers	10 x 10	2 tons
Cotton	Gossypium spp.	Temperate to Tropical	10 lbs	3 x 1	100 lbs
Jute	Corchorus spp.	Tropical	12 lbs	½	1200 lbs
Kenaf	Hibiscus cannabinus	Tropical	30 lbs	2 x ½	1200 lbs
Ramie	Boehmeria nivea	Tropical	root cuttings	1 x 1	1000 lbs
Sisal	Agave sisalana	Temperate to Tropical	suckers or bulbils	6 x 6	600 lbs
		Miscellaneous			
Flax	Linum usitatissimum	Temperate to Tropical	30 lbs	broadcast	400 lbs
Sesame	Sesamum indicum	Tropical	10 lbs	broadcast	700 lbs
Sugarcane	Saccharum officinarum	Temperate to Tropical	stem cutting	5 x 5	40 tons
Sunflower	Helianthus annus	Temperate to Tropical	10 lbs	1 x 2	100 lbs
Tobacco	Nicotiana spp.	Temperate to Tropical	seedling transplants	3 x 3½	500 lbs

Sowing & Planting Distances

Feet	Meters	Number of Plants Per	
		Acre	Hectare
2 x 1	0.6 x 0.3	21 780	55 555
2 x 2	0.6 x 0.6	10 890	27 777
3 x 1	0.9 x 0.3	14 520	37 037
3 x 2	0.9 x 0.6	7 260	18 518
3 x 3	0.9 x 0.9	4 840	12 346
4 x 1	1.2 x 0.3	10 890	27 777
4 x 2	1.2 x 0.6	5 445	13 889
4 x 3	1.2 x 0.9	3 630	9 259
4 x 4	1.2 x 1.2	2 722	6 944
5 x 4	1.5 x 1.2	2 178	5 555
5 x 5	1.5 x 1.5	1 740	4 444
6 x 6	1.8 x 1.8	1 210	3 086
7 x 7	2.1 x 2.1	889	2 267
8 x 8	2.4 x 2.4	680	1 736
9 x 9	2.7 x 2.7	537	1 371
10 x 10	3.0 x 3.0	435	1 111
12 x 12	3.6 x 3.6	302	171
15 x 15	4.5 x 4.5	200	494
18 x 18	5.4 x 5.4	135	343
20 x 20	6.0 x 6.0	110	278
25 x 25	7.5 x 7.5	70	178
30 x 30	9.0 x 9.0	50	123
35 x 35	10.5 x 10.5	35	91
40 x 40	12.0 x 12.0	27	69

Pollination of Crops

Mode of Pollination of Chief Crops

Group 1. Normally Self-pollinated

Soya-beans, groundnuts, jute, wheat, barley, oats, linseed.

Group 2. Chiefly Selfed, Occasionally Crossed

Rice, sorghum, cotton, tobacco. sesame.

Group 3. Both Selfed and Crossed Naturally

Cacao, citrus, sunflower.

Group 4. Chiefly Crossed, Occasionally Selfed

Coffee (Robusta rather self-sterile, Arabica strongly self-fertile).

Group 5. Normally Cross-pollinated

Tea, maize, rubber, coconut, oil-palm, pasture grasses, rye, Brassicas, sugar-beet, mangold, pyrethrum.

Group 6. Vegetatively Propagated, but both Methods possible

Sugar-cane, sisal, European potatoes, banana.

Processing Ratios of some Tropical Crops
(all approximate)

Cassava	100 lb roots give 18 lb peelings and 36 lb of dry Cassava
Rice	100 lb of Paddy when hulled gives 60 lb of rice
Finger millet	100 lb of green heads give 58 lb of dried heads and 45 lb of threshing grain or 100 lb of dry heads give 78 lb of grain on threshing
Groundnuts	100 lb of groundnuts on shelling give 60-70 lb of kernels
Cocoa	12 pods containing an average of 30 beans are required to produce 1 lb dried cocoa
Arabica coffee	100 lb of cherry gives about 20 lb of beans. 100 lb of parchment gives about 88 lb of beans
Robust coffee	100 lb of fresh cherry gives 50 lb of dry cherry and 100 lb of dried cherry gives about 50 lb of beans on hulling
Cotton	100 lb of seed cotton gives 30-33 lb of lint

Average Composition and Digestible Nutrients

Feeding stuff	Total dry matter	Dig Protein	Total dig. nutrients	Average total composition				
				Protein	Fat	Fiber	Calcium	Phosphorus
	%	%	%	%	%	%	%	%
Concentrates								
Barley, common	89.4	10.0	77.7	12.7	1.9	5.4	0.06	0.40
Beet pulp, dried	91.2	4.1	68.7	8.8	0.6	19.6	0.69	0.08
Bone meal, steamed	95.5	. .	. .	7.5	1.2	1.5	30.14	14.53
Buckwheat	88.0	7.4	62.2	10.3	2.3	10.7	0.09	0.31
Citrus pulp, dried	90.0	2.7	74.9	6.2	3.4	11.6	2 04	0.15
Coconut oil meal, solvent	91.1	18.2	68.6	21.4	2.4	13.3	. .	. .
Corn dent, No. 2	85.0	6.7	80.1	8.7	3.9	2.0	0.02	0.27
Corn dent, soft	66.1	5.4	60 6	7.0	2.2	2.3	. .	0.24
Corn bran	90.4	5.6	69.4	9.8	7.4	8.9	0 04	0.14
Cottonseed meal 43%	92.8	35.9	72.6	43.3	5.1	11.0	0.23	1.07
Distillers dried corn grains, without solubles	94.4	19.1	84.0	26.1	8.9	12.8	0.11	0.48
Fish meal, all analyses	92.0	53.6	70.8	60.9	6.9	0.9	5.36	3.42
Linseed meal, exp.	91.1	30.6	75.5	35 2	4.6	8.9	0.37	0.86

Average Composition and Digestible Nutrients (*continued*)

Feeding stuff	Total dry matter %	Dig. Protein %	Total dig. nutrients %	Average total composition				
				Protein %	Fat %	Fiber %	Calcium %	Phosphorus %
Concentrates								
Meat & Bone scrap, 50%	93.7	40.8	65.3	49.7	10.6	2.2	10.67	5.27
Milk, cow's	12.8	3.3	16.3	3.5	3.7	0	0.12	0.10
Millet seed, fox tail	89.1	8.6	75.7	12.1	4.1	8.6	. .	0.20
Milo grain	89.0	8.5	79.4	10.9	3.0	2.3	0.03	0.28
Molasses, cane	73.4	0	53.7	3.0	0	0	0.66	0.08
Oats	90.2	9.4	70.1	12.0	4.6	11.0	0.09	0.33
Pea seed, field	90.7	20.1	77.9	23.4	1.2	6.1	0.17	0.50
Peanut meal, solvent 50%	93.0	47.6	77.3	52.3	1.6	6.9	. .	. .
Potato pulp, dried	87.7	5.6	78.5	7.3	0.4	7.7	. .	. .
Rice bran	90.8	8.4	67.4	12.4	13.6	11.6	0.08	1.36
Rice grain, rough	88.8	6.0	70.2	7.9	1.8	9.0	0.08	0.32
Skimmilk, dried	93.9	29.8	79.8	33.1	1.1	0.6	1.28	1.04
Sorghum grain, dwarf	89.6	8.4	79.9	10.8	2.8	2.3	0.02	0.32

Average Composition and Digestible Nutrients (*continued*)

Feeding stuff	Total dry matter %	Dig. Protein %	Total dig. nutrients %	Average total composition				
				Protein %	Fat %	Fiber %	Calcium %	Phosphorus %
Concentrates								
Soybean oil meal solvent	90.4	42.0	78.1	45.7	1.3	5.9	0.29	0.64
Tankage, digester 60%	92.8	50.5	65.8	59.4	7.5	1.9	6.37	3.23
Wheat, hard winter	89.4	11.3	79.6	13.5	1.8	2.8	0.05	0.42
Wheat bran	90.1	13.3	66.9	16.4	4.5	10.0	0.13	1.29
Dry Roughages								
Alfalfa hay, all analyses	90.5	10.9	50.7	15.3	1.9	28.6	1.47	0.24
Alfalfa meal, dehydrated	92.7	12.4	54.4	17.7	2.5	24.0	1.60	0.26
Bermuda grass hay	90.5	3.6	44.2	7.1	1.8	25.9	0.37	0.19
Clover and mixed grass hay, high in clover	89.6	5.5	51.8	9.6	2.7	28.9	0.88	0.21
Corn cobs, ground	90.4	0	45.7	2.3	0.4	32.1	0.11	0.04
Cottonseed hulls	90.8	0	43.7	3.9	0.9	45.0	0.13	0.06
Cowpea hay	90.4	12.3	51.4	18.6	2.6	23.3	1.37	0.30

Average Composition and Digestible Nutrients (*continued*)

Feeding stuff	Total dry matter %	Dig. Protein %	Total dig. nutrients %	Average total composition				
				Protein %	Fat %	Fiber %	Calcium %	Phosphorus %
Dry Roughages								
Oat hay	88.1	4.9	47.3	8.2	2.7	28.1	0.21	0.19
Rice straw	92.5	0.6	41.5	3.9	1.4	33.5	0.19	0.07
Sudan grass hay	89.4	4.3	48.6	8.8	1.6	28.0	0.36	0.27
Green Roughages								
Alfalfa, green, all	24.4	3.5	14.8	4.6	0.9	6.7	0.40	0.06
Clover, Ladino, pasture	16.6	3.3	12.4	4.1	0.8	2.5	0.21	0.07
Cowpeas	16.3	2.2	10.8	3.0	0.5	3.8	0.25	0.05
Oat pasture, immature	14.1	2.4	9.2	3.2	0.6	2.8	0.06	0.09
Pasture, mixed	22.0	3.8	15.0	5.0	0.9	4.8	0.14	0.08
Silages								
Corn, dent, well-matured	27.6	1.2	18.3	2.3	0.8	6.7	0.10	0.07
Cowpea, wilted	30.0	2.6	17.8	4.5	1.2	8.5	0.48	0.10
Grass silage, considerable legumes, wilted	33.3	2.9	19.1	5.2	1.3	8.8	..	..

The Chemical Composition of some Tanganyika Feeding Stuffs

	Normal dry matter	Dry Matter Composition (%)				
		Crude Protein	Ether Extract	N-free Extract	Crude Fiber	Total Ash
Cassava Tubers	20	3.6	1.0	85.4	5.0	5.0
Edible Canna Tubers	30	3.6	0.8	84.8	3.4	7.4
Sweet Potato Tubers	30	5.1	1.1	87.5	2.8	3.5
Edible Canna Tops	18	10.2	5.1	48.5	19.7	16.5
Sweet Potato Tops	17	16.0	5.6	23.3	45.0	10.1
Maize, cobs milk 6-7 ft.	17	8.8	0.9	54.8	28.1	7.4
Millet, seed forming, 6-7 ft.	20	7 6	1.5	50.5	32.6	7.8
Bulrush millet, flowering heads emerging, 4-6 ft.	15	13.7	1.7	42.2	27.5	14.9
Lucerne, wet season growth, budding	30	20.6	2.4	42.3	24.9	9.8
Maize stover	88	5.0	1.1	52.5	34.7	6.7
Millet stover	88	4.3	1.2	47.0	37.2	10.3
Bulrush millet stover	88	4.3	0 9	41.9	43.6	9.3
Banana plants (whole plant)	5.10	6.4	0.8	56.0	23.7	13.1
Banana leaves	15	8.2	3.2	47.1	29.8	11.7
Acacia arabica, pods and seeds	90	12.9	2.5	63.8	15.2	5.6

The Chemical Composition of some Tanganyika Feeding Stuffs (*continued*)

	Normal dry matter	Dry Matter Composition (%)				
		Crude Protein	Ether Extract	N-free Extract	Crude Fiber	Total Ash
Bulrush millet, whole	87	14.1	4.5	76.4	3.1	1.9
Maize, crushed	88	8.9	2 8	82.6	3.2	2.5
White millet, whole	87	12.0	3.3	78.9	3.3	2.5
Cowpeas	86	26.9	1.4	61.6	6.5	3.6
Maharage beans	88	23 1	1.4	66.6	4.8	4.1
Velvet beans	88	24.0	4.4	58.6	9.2	2.9
Cottonseed	89	20.3	15.2	32.1	27.0	5.4
Maize bran	86	8.8	10.1	68.0	7.0	6.1
Millet bran (white variety)	88	13.8	6.0	65.3	6.2	8.7
Rice glumes	90	3.8	3.2	38.8	43.7	10.5
Rice bran	88	13.3	10.1	45.7	18.3	12.6
Rice polishings (first run)	87	17.0	15.3	55.1	5.9	6.7
Wheat bran	88	14.9	3.7	65.0	12.3	4.0
Coco-nut cake	89	21.7	15.0	39.2	15.2	8.9
Groundnut cake (machine milled)	88	43.3	6.9	38.0	5.9	5.9
Groundnut cake (brade punitive mill)	88	53.2	8.9	27.8	4.8	5.3
Sesame cake	88	43.2	11.6	27.1	6.5	11.6

Mean Chemical Composition of some Nigerian Grasses

(dry-matter basis)

Name of Grass	Dry matter (%)	Crude protein (%)	True protein (%)	Ether extract (%)	Crude fiber (%)	Nitrogen-free extract (%)	Silica-free ash (%)
Andropogan gayanus (Gamba grass)	29.5	7.4	6.8	1.2	32.3	50.8	4.5
Chloris gayana (Rhodes grass)	34.2	8.4	6.9	1.4	30.1	50.5	5.0
Cynodon plectostachyum (Giant Star grass)	36.4	7.5	6.4	1.1	30.6	51.9	5.2
Eleusine indica (Annual)		8.3	7.1	1.0	32.0	49.7	3.5
Melinis minutiflora (Molasses grass)	29.4	6.8	6.1	1.6	33.7	50.1	4.9
Panicum maximum (Guinea grass)	30.9	8.2	6.6	1.0	33.8	43.3	6.8
Paspalum conjugatum		6.6	5.6	1.2	30.2	54.2	5.2
Pennisetum pedicellatum (Kyaswa grass) (annual)		7.6	6.7	1.2	35.1	44.9	6.2
Pennisetum purpureum (Elephant grass)		9.2	7.9	1.3	30.9	42.1	7.7
Setaria sphacelata (Golden Timothy grass)		6.5	5.6	1.4	33.0	46.1	8.1

Reproduction of Farm Animals

(A) Gestation Periods

Animal	Shortest period	Average all in days	Longest period
Mare	305	340	400
Donkey	365	374	385
Cow	210	283	353
Buffalo	290	310	330
Ewe	140	147	160
Goat	148	155	165
Sow	109	112	130
Rabbit	25	32	35

(B) Incubation Periods

Bird	Average time to hatch (days)
Hen	21
Duck	28
Guinea-fowl	28
Turkey	28
Goose	30
Pigeon	20

(C) Periods of Oestrum

Animal	Duration of heat	First heat after birth	Recurrences
Mare	3–9 days	7–11 days	2– 4 weeks
Cow	1–2 days	1–2 months or more	16–24 days
Buffalo	1–3 days	2–3 months or more	3– 4 weeks
Ewe	1 day	2–6 months	2– 3 weeks
Goat	1–3 days	1–3 months	18–21 days
Sow	3–4 days	5–6 days from weaning	15–30 days

Cattle Diseases Limited To Tropical Areas — Symptoms And Control

Disease	Symptoms	Control
East Coast Fever — piroplasmosis Tick-borne enzootic.	Tick-borne disease resulting in high fever—attacks all farm animals.	Eradication of ticks.
Texas Fever — sperochaetosis Tick-borne enzootic.	Urine red in color accompanied by high fever.	Eliminate ticks.
Trypanosomiasis — Surra Dourine	Diseases caused by or transmitted by tsetse flies are many and usually of the venereal type.	Eliminate tsetse fly. New drugs are being tried with some successes.
Rinderpest	Contagious and has rapid course—Inflammation of respiratory and digestive tracts — ulceration of mouth, etc.	Vaccination.
Bovine Pleuro-pneumonia	Fever and pneumonia	Injections and eradication of infected animals.
Anthrax bacterial	Fever and Trembling	Vaccination

Average Composition of Milk Products

Type of Milk or product	Dry Matter %	Fat %	Protein %	Lactose %	Ash %
Cow (Bos taurus)	12.59	3.78	3.29	4.70	0.76
Cow (Bos indicus)	13.30	4.50	3.30	4.80	0.70
Buffalo (Bos Bubalis)	18.59	7.47	6.10	4.15	0.87
Goat	14.29	4.78	4.29	4.46	0.76
Mare	9.30	1.20	2.00	5.70	0.40
Sheep	19.18	6.86	6.52	4.91	0.87
Pig	15.96	4 55	7.23	3.13	1.05
Cow Colostrum	18.00	3.84	9.33	3.52	0.97
Butter	85.00	84.50	0.20	0.40	0.15
Buttermilk	9.10	0.20	3.30	5.30	0.70
Whey	6.85	0 30	0.72	5.00	0.54
Skim Milk	9.15	0.05	3.38	4.95	0.74
Powdered Dried Milk	95.80	26.50	25.50	32.90	6.40
Powdered Skim Milk	89.70	1.50	32.80	47.90	7.50

Pesticides & Herbicides

The information given here deals only with the chemicals used and does not go into the intricacies of the why and wherefore. This field is changing so rapidly that little can be said that will not be changed by the time this manual is published.

Insecticides

Hydrocarbon Chlorides (For Plants or Animals)

All of this group may be used as liquid sprays or as dusts. Most are patented and may appear under numerous trade marks. (See directions on container).

DDT — 75 grams per 100 liters for large scale spraying. For small volume spraying use:

DDT — emulsion (basic emulsion)

Powered DDT	½ lb
Tetraline solvent	¾ pt
Triton B 1956 or Tepol	2 oz
Water	1½ pts

Dilute emulsion in water as follows:

(a) large insects — 1 part emulsion to 3 parts water
(b) medium size insects — 1 part emulsion to 6 parts water
(c) small delicate insects — 1 part emulsion to 12 parts water.

Where dusting is required, DDT containing 1 to 10% active ingredient is used. 5% active ingredient is usually the concentration adopted for general use. In case it is desirable to eradicate mosquitoes or flies use a solution of 5% DDT dissolved in Kerosene.

BHC is used as a dusting powder or as a spray. May be mixed with DDT for spraying or dusting cotton (17 lbs per acre).

Chlordane — effective against ants and cockroaches. Can be obtained as an emulsion or powder. (Use specific directions on container.)

Aldrin can be obtained as an emulsion or wettable powder. Use 4—12 oz per acre against cotton insects. As a soil fumigant use ½ to 5 lbs per acre.

Dieldrin — similar to Aldrin.

Endrin — toxic to mammals and should be used with caution. Use 0.1 to 0.5 lbs per acre. An excellent all-purpose plant spray.

Organic Phosphorus Compounds
(For Plants or Animals)

This group of insecticides is generally *Poisonous to man* and should be mixed and used with extreme caution.

Parathion — mix into 450 quarts emulsion 5 ounces of 20% Parathion—general purpose insecticide.

TEPP — use directly as a general insecticide.

Malthion — emulsify 5 ounces of 20% Malthion in a white oil and spray for flies, mosquitoes, etc.

Flouride Mixtures

Sodium Flouride — for fruit flies use one ounce of sodium flouride mixed with 2 pounds of sugar and 4 and ½ gallons of water. Spray plants weekly.

Arsenicals

Arsenate of Lead — for use against chewing insects — mix a paste with water using 2 ounces of arsenate of lead. Add the paste to 9 or 18 gallons of water depending on strength desired. To prevent leaf burning add 4 or 5 ounces of lime.

Sodium Arsenate — mix 2 ounces of sodium arsenate with ½ lb of sugar and 18 quarts of water. Use as a mist spray. The chemical may be used as a bait for chewing insects Use mixture of chopped hay soaked in a solution of ½ lb of Sodium Arsenate, five pounds of sugar and 18 quarts of water. When dry spread around infested area.

Paris Green — used as a bait — mix 5 pounds of Paris Green with 4 quarts of molasses and five gallons of water — mix well with bran and dry.

Vegetable Origin

Nicotine — use as a spray on plants. Dissolve 4 ounces of soap in 18 quarts of water and add 1 ounce of 40% nicotine sulphate or strong tobacco water — use as spray.

Pyrethrum — Irreplaceable as a fly and mosquito killer — may be used as a dust on plants or animals or as a spray.

Derris — Used largely as a dust .5% rotenone or as a spray. Comes from the Derris root commonly found in the Tropics. Has a very high killing power because it is an external as well as an internal poison.

Systemics — These are among the newest and most efficient insecticides and are known as Schradan, Lyslox, etc. in the trade. The substance is placed in the soil where it is translocated to all parts of the plants. Insects which feed on the plant become poisoned.

Fungicides

Bordeaux Mixture — This perhaps is the oldest and best known plant fungicide in existence today. It is prepared by mixing 2½ pounds of copper sulphate dissolved in water and 2½ lbs of active lime dissolved in water and the two are then added to water sufficient to bring the total to 100 gallons (use as a spray).

Lime Sulphur — This is another old style fungicide and insecticide used for both plants and animals. It is difficult to prepare and should be purchased in bulk form. If it must be home-made, mix 4 lbs of quick lime with 4½ lbs of sulphur in 10 gallons of water to form a paste. When slaking is complete add 10 more gallons of water and boil for one hour. Dilute 10 times for using as dip or spray.

IMTD — Commercial product used for seed treatment.

There are other commercial fungicides but the first two mentioned above are still most generally used.

Herbicides

There are a great many commercial products used for weed destruction and it would take several volumes to exhaust the subject. In general they consist of chemicals such as sodium chlorate which is directly poisonous to the plant, to systemic poisons such as 2,4-D which actually cause the plant to grow itself to death. A further refinement are those chemicals used as pre-emergence killers.

Following are a few of the contact herbicides :

Sulphuric Acid — mix 12 parts of concentrated sulphuric acid with 88 parts of water and use as a spray.

Copper Sulphate — Use a 4% solution as a spray.

Chlorate of Sodium or Potassium — Use a 2 to 10% solution as a spray depending on hardiness of weed to be killed.

DNBP — 4,6 — Dinitro-o-sec-butilfenol — excellent for the Tropics.

Used motor oil is effective also as an herbicide, as is diesel fuel.

Herbicides which are systemic, i.e. which kill by translocation within the plant tissue are also innumerable and efficient. Since these are purchased under trade names, with adequate instructions on the container, only a few will be noted.

2,4-D — only the salt form is not volatile and carried by the air currents to other plants, i.e. esters such as weedone should not be used in close proximity to plants not to be damaged. (Read instructions on the container carefully).

2,5-4T — similar to 2,4-D but is used on *woody plants*, such as trees and shrubs — spray in kerosene solution or ½ lb in 25 gallons of water — very effective.

Other weedicides

TCA — Used to eradicate grasses
MCPA — Similar to 2,4-D
CMU — Pre-emergence
IPC — General spray
CIPC — Annual weeds
NP — Pre-emergence

Making Dilutions — Most control recommendations designate the strength of the spray solution to be used as so many parts by volume or weight per 50 or more gallons of water or other liquid, such as "1-50," "3-50," or "6-100," "1-800," etc. This terminology may also be used by manufacturers on the labels of packaged insecticides. Unless otherwise stated, it means that so many parts by liquid measure (of liquid) or by weight (of dry material) are used to make up the designated number of gallons of spray. For example, the recommendation, "nicotine sulfate "1-800", means that 1 gallon of the commercial nicotine sulfate containing 40 percent of active ingredients is to be diluted with water or other liquid up to the total volume of 800 gallons of spray. Likewise, the recommendation, "arsenate of lead 3-50", means that 3 pounds of this dry material are used to make up 50 gallons of spray, the same proportion or rate being used whether larger or smaller quantities of spray are prepared.

The proportionate amounts of liquid material needed to make up commonly used quantities of spray are given in table below for most of the usual dilutions. Amounts needed for other quantities and other dilutions can be conveniently calculated from these figures. Similar information for dry material is given in succeeding table.

Amount of liquid material to make sprays of certain dilutions

Dilution	Volume * of liquid material to make —			
	50 gallons	5 gallons	3 gallons	1 gallon
1–50	1 gallon	26 T.	1 C.	16 t.
1–100	½ gallon	13 T.	8 T.	8 t.
1–200	1 quart	7 T.	4 T.	4 t.
1–400	1 pint	3 T.	2 T.	2 t.
1–600	2/3 pint	2 T.	4 t.	1 1/3 t.
1–800	1 C.	5 t.	3 t.	1 t.
1–1,000	13 T.	4 t.	2¼ t.	¾ t.

* All measures are United States standard containers: gal. = gallon, qt. = quart, pt. = pint, C. = measuring cup, T. = Tablespoonful, t. = teaspoonful.

Dilution	Amount of dry material to make sprays of certain dilutions Weight of dry material to make —			
	50 gallons	5 gallons *	3 gallons *	1 gallons *
	Pounds	Ounces	Ounces	Ounces
1–100	0.5	0.8	0.48	0.16
2–100	1.0	1.6	.96	.32
3–100	1.5	2.4	1.44	.48
4–100	2.0	3.2	1.92	.64
5–100	2.5	4.0	2.40	.80
6–100	3.0	4.8	2.88	.96
8–100	4.0	6.4	3.84	1.28

* Amounts for 1 to 3 gallons of spray can usually be measured more conveniently by bulk. Multiply amounts here given by bulk shown in tabulation on page 47

To insure a uniform spray mixture, liquid material is first diluted gradually by stirring in small amounts of water up to a total of about twice the original volume. Dry material is similarly made into a smooth thin paste. Materials thus broken up are added directly, or preferably through a sieve, to the half-filled spray tank, and thoroughly stirred while the tank is being filled to make the total quantity of spray needed. Thorough agitation should be provided during application to prevent the settling of suspended materials, such as arsenate of lead and DDT.

Liquid Measure — The usual United States units and their abbreviations are given in the following tabulation. Metric units are given in parentheses.

3 teaspoonfuls (t.)	=	1 Tablespoonful (T.) (15 milliliters) (ml.)
2 Tablespoonfuls (T.)	=	1 fluid ounce (fl. oz.) (30 milliliters)
8 fluid ounces	=	1 cup (C.) (237 milliliters)
2 cups	=	1 pint (pt.) (473 milliliters)
2 pints	=	1 quart (qt.) (946 milliliters)
4 quarts	=	1 gallon (gal.) (3.8 liters (l.))

Weight — The avoirdupois ounce (oz.) is equivalent to approximately 28.3 grams (gm.). Sixteen ounces equal one pound (lb), or approximately 454 grams.

The following tabulation shows the approximate number of level tablespoonfuls (T.) of dry material needed to weigh 1 ounce:

Materials	Level tablespoonfuls (T.) per ounce
Arsenate of lead	4½
Arsenate of calcium	5
Paris green	1½
Cryolite	2 2/3
Barium fluosilicate	4
Sodium fluosilicate	2
Derris or cube root powder (5% rotenone content)	6
Hydrated lime	3
Wettable sulphur	4
Paradichlorobenzene	2½
Wheat flour	4½
Soybean flour	6 1/3
Corn meal	3 2/3
Metaldehyde (meta)	7
BHC, 50%, wettable powder (5% gamma isomer content)	3 2/3*
DDT, 50%, wettable powder	4*

* Since the carriers or diluent powders used in these materials vary a great deal in bulk, the gardener should determine the bulk of his particular brand by actual weight and measurement before using this method

Summary of the main herbicides used in the Tropics

Amitrol (ATA) 3 amino-1,2,4,-triazole. Readily absorbed by roots and aerial plant parts causing severe chlorosis. Actively translocated. Kills both broadleaved and grass weeds. Little persistence in the soil. Cotton defoliant.

Atrazine 2-chloro-4-ethylamino-6-isopropylamino-S triazine. A pre-emergent herbicide, slightly more soluble than simazine. Active through the leaves as well as the roots. Field of use similar to simazine. More effective under drier conditions.

2,4-D (as amine or ester) 2,4-dichlorophenoxyacetic acid. The most used herbicide in the world. Selectively removes broadleaved weeds from cereals and sugar cane. Used pre-emergence on groundnuts. Used alone or in mixtures as a directional spray in other broadleaved crops.

2,4-DB, 4-(2,4-dichlophenoxy) butyric acid. Activity depends upon oxidation to 2,4-D in the plant. Specifically used on lucerne. Controls a limited range of broadleaved weeds.

Dalapon 2 2-dichloropropionic acid. A water soluble grass killer. Absorbed by the foliage and roots. Most effective when grass actively growing. Can be used in many tree crops if carefully applied. Also used for removing grass from irrigation and drainage ditches.

Diquat 1,1-ethylene 2,2-dipyridylium dibromide. A non-selective contact weed-killer, rapid in action. Can be used for destroying oil palms. Defoliant.

Related chemical Parquat may have wider usage. Inactivated on contact with soil.

MCPA 4-chloro-2-methylphenoxyacetic acid. Selectively removes broadleaved weeds from cereal crops. Used also in sisal.

MCPB 4-(4-chloro-2-methylphenoxy) butyric acid. Activity depends upon oxidation to MCPA in the plant. Selective to legumes in particular. Controls a limited range of weeds.

Monuron (CMU) N-(4-chlorophenyl)-N, N-dimethyl urea. A selective, persistent herbicide of low solubility. Also used as a soil sterilant. Used on cotton in southern U.S.A., also citrus, sugar cane and pineapples. Related herbicides diupon, fenupon, and nebupon have not been developed yet.

P.C.P. Pentachlorophenol. Used as a timber protectant, particularly in the tropics against termites, also as a contact herbicide in sugar cane, alone or with 2,4-D and oil, and in irrigation canals for the control of Salvinia and other weeds. Some hazards to user, must be handled with care.

Sodium arsenite A non-selective contact weedkiller. Toxic when ingested. Acute oral LD mammals 10-15 mg/kg. Used for tree poisoning, general weed control including lalang in Malaya. Dangerous to fish and grazing animals. Due to the poisoning risk to livestock, its use is discouraged in some countries.

Sodium chlorate A non-selective weedkiller. Imparts a fire hazard to sprayed material. Used in

mixtures with more persistent herbicides.

Simazine 2-chloro-4, 6-bisethylamino-S triazine. A nearly insoluble pre-emergent, selective herbicide for use in maize, sugar cane, rubber, tea, oil palms, etc. Also used as a soil sterilant.

2,4,5,-T 2,4,5,-Trichlorophenoxyacetic acid. Used as ester in oil or water to kill trees and scrub. Also used as a latex stimulant in rubber.

T.C.A. Trichloroacetic acid. A grass killer, not as active as dalapon. Root absorbed.

Oil Certain oils marketed as Lalang Oil or Sovacide, etc., are used to eliminate small remaining patches of lalang (Imperata cylindrica) in Malayan rubber estates. The oil is wiped on the leaves with a rag. The oil is non-toxic to humans and animals, but toxic to rubber seedlings and other plants.

Quantity of Fertilizer to be applied per 25 linear feet of row at various spacings between rows and various rates of application

Distance between rows (inches)	Approximate quantity of fertilizer* per 25 feet of row on basis of —					
	200 pounds per acre	400 pounds per acre	600 pounds per acre	800 pounds per acre	1,000 pounds per acre	1,200 pounds per acre
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
12	0.12	0.25	0.35	0.50	0.60	0.75
18	.18	.37	.55	.75	.90	1.10
24	.25	.50	.75	1.00	1.25	1.50
30	.30	.62	.90	1.25	1.50	1.80
36	.37	.75	1.10	1.50	1.80	2.20
42	.43	.85	1.25	1.75	2.10	2.50
48	.50	1.00	1.50	2.00	2.40	3.00

* Roughly, 6 to 9 medium handfuls of fertilizer will weigh 1 pound. This will vary, of course, with hand size and the weight of the fertilizer.

Quantity of Plant Nutrients Removed From Soil By Different Crops

Crop	Yield (lb per acre)	Quantity of nutrients removed (lb per acre)		
		N	P_2O_5	K_2O
Rice	2,000	30	20	60
Wheat	1,400	50	21	60
Maize	1,800	32	18	35
Sugarcane	60,000	80	15	180
Groundnut	1,700	70	20	40
Linseed	900	17	11	29
Cotton	400	27	15	40
Jute	1,400	60	30	60
Coffee	800	30	10	30
Tobacco	1,300	84	51	81

Average Nutrient Content of Manures

Manure	Percentage content (approx.)		
	Nitrogen (N)	Phosphoric acid (P_2O_5)	Potash (K_2O)
Animal refuse			
Dung, cattle, fresh	0.3	0.1	0.1
Dung, horse, fresh	0.4	0.3	0.3
Dung, sheep, fresh	0.5	0.4	0.3
Poultry manure, fresh	1.0	1.4	0.8
Sewage, raw, fresh	2.0	..	..
Wood ashes			
Ash, coal	0.73	0.45	0.53
Ash, wood	0.1	2.5	3.5
Farm, factory and habitation wastes			
Compost, rural, dry	0.5	0.4	0.8
Farmyard manure, dry	0.4	0.3	0 3
Filter press cake	1.0	4.0	2.0
Plant Residues			
Hulls, rice	0.3	0.2	0.3
Husks, groundnut	1.6	0.3	1.1
Straw and stalks	0.65	0.75	2.50
Green manures, fresh			
Cowpea (Vigna catjang)	0.71	0.15	0.58

CHAPTER 2

Tropical Climate And Soils

Since climate is the limiting factor for both plant and animal existence and, at the same time, the greatest factor influencing soil formation, and to a lesser extent topography, it must be mentioned in this manual. True there is little that can be done about climate but if one understands it, he can learn to adjust to it and thus learn to live with it. Its importance here is to explain briefly what a tropical climate consists of in order that the agriculturist can choose within its wide variations a place to live and the crops he will grow.

In the tropics, climate depends largely on the latitude and altitude. For example, it is usually hottest at the equator at sea level and cooler with distance away, i.e. distance outward and distance upward from sea level. For every 300 feet in elevation, there is a drop of 1 degree in temperature Thus with so many factors affecting climate, one can speak in generalities. In most tropical countries there are four distinct climatic zones, (1) hot moist, (2) hot dry, (3) intermediate and (4) cool zone. For each one of these zones, there is a set of ecological conditions optimum for certain types of vegetation, and although there is considerable overlap most plants are best grown under the conditions of climate and soil to which they are ecologically adapted. In this manual, whenever there is mention of a new species an effort has been made to indicate its climatic zone.

In trying to visualize rainfall patterns in the tropics, a simple method described by

G.B. Masefield of the Imperial College of Tropical Agriculture is perhaps the most useful:

"Within a few degrees of the equator, the rains are said to follow the sun in the two annual passages overhead which it makes as it passes from the equator to either tropic and back again. The rainy seasons spoken of as 'first' and 'second' or the 'greater' and 'lesser,' thus fall in the late spring and late autumn and these are the main crop planting seasons. The rains gradually slacken off to be followed by dry seasons in late summer and late winter when annual crops are harvested. Toward the outer limits of both tropics, the sun's two passages overhead naturally fall closer together and the seasons tend to coalesce into one long wet season and one long dry season of six months each."

While this explanation is overly simplified, it does give an excellent idea of how it should always work if it were not for other complications.

As mentioned previously, soils are greatly influenced by the climate in which they are formed and in the humid tropics with high rainfall and temperatures, a typical soil formation exists which is known as lateritic. Such soils are often characterized by deep red color, hard granules or pebbles, high iron and aluminium content and tendency to become rock hard upon drying. All phases of laterization occur in the humid tropics and in most instances the soils are very infertile and highly acid. The soils are high in clay but are easily worked even when wet. Under conditions of less rainfall tropical soils vary in color from black to brown or grey. These soils are often rich

in natural fertility but because of the high clay content may be subject to cracking.

Most tropical soils are low in organic matter and respond well to manure and green organic matter, although the organic matter content is short lived due to high temperature and moisture. These soils can be highly productive when properly handled but there are few tropical farmers who have given this much thought. Experimental data indicate that most tropical crops can be doubled through the use of fertilizers and many crops have had their yields tripled and more. (See the following chapter on fertilizers).

Physical Geography, Soils and Climate of Burma

Burma lies between 93° and 103° E. longitude and 28° and 10° N. latitude. The country is 800 miles long and 500 miles across (262,000 square miles). The Tenasserim coastal strip extends another 300 miles to the south. The country is bounded on the north by the Arakan Yomas hills and the Nagas. The Chin & Lushai hills form the boundaries. The north east is bounded by the Kachin and Shan hills and on the south east by the Shan and Tenasserim hills. The highland plateau of the Shan hills covers all of east and central Burma. Even the central plain of Burma is divided by the Pegu Yomas hills. The rest of Burma consists of valleys and deltas of the major rivers and it is in these valleys and deltas where the bulk of the agricultural activity is centered. (See following map).

Approximate climatological data selected from data collected over a 5 to 44 year period are present-

ed in the following summary. These may be used as a guide in recommending planting areas. The data are divided into 8 geographical regions, each region being a complete drainage area. (*See Table page* 64)

Region 1 — Bengal Drainage — Area west of the Irrawaddy draining into the Bay of Bengal.

Region 2 — Chindwin River Basin

Region 3 — Irrawaddy River Basin above Myingyan

Region 4 — Irrawaddy River Basin from Myingyan to mouth

Region 5 — Salween River Basin

Region 6 — Mekong River Basin

Region 7 — Andaman Drainage including Pegu, Sittang and other basins north of the mouth of the Salween draining into the Gulf of Martaban.

Region 8 — Tenasserim Drainage, including areas south of the Salween river and includes Gyaing and Attaran rivers.

Soils and Vegetation

No technical information on soils or plant ecology is available but the leached soils in the high rainfall belt, the deep alluvial soils in the mountain valleys and the laterite soils scattered throughout the country indicate that Burma has similar edaphological and ecological conditions as are

common to other tropical countries in the same geographical location.

For practical purposes and to meet the minimum needs for this handbook, Burma is divided into four agricultural regions, (see following map); (1) Upper Burma, (2) Lower Burma, (3) Central Burma and the (4) Shan Kayah region. The reason for this breakdown is of course based on climatological, ecological, and geographical differences, which have been noted on the map. From this map one can deduct possible planting locations from data presented in the ensuing chapters.

Burmese Agriculture

Burmese agriculture is still the agriculture of antiquity, dependent for the most part on hand labor, animal traction and seed passed down from the centuries. The Burmese farmer still relies on natural rainfall; and the seven to ten acres that he owns or cultivates is often divided in small plots and in each of these he employs different spacing, seeding rates, etc. depending on the variety and the prevailing conditions. Burma is a one crop country regardless of the season. In general the crops may be short season or long season such as 200 day paddy and 90 day sorghum, but seldom do the Burmese plant more than one crop a year on the same ground regardless of season or growing conditions. (This practice is changing in favor of a multicropping system)

Of importance to the Burmese farmer are the prevailing cropping seasons, the local soil descriptions and the crops.

Seasons

(1) Monsoons (Rainy Season)— Lower Burma May to Oct.	—	200 to 90 inches-continuous rainfall.
Upper Burma May to Sept.	—	25 to 40 inches in central zone and 100 inches in northern zone.
(2) Cold Season (Winter) Lower & Upper Burma	—	From November to Feb. Warmer in Lower Burma. Almost rainless in Upper Burma. Once in 5 or 10 years North East wind brings odd showers which damage rice at harvest.
(3) Hot Season (Summer) Lower & Upper Burma	—	March to May 15. Few storm showers in lower Burma in early May. Dry and windy with 100° to 110°F. temperature in upper Burma. 100°F. in lower Burma.

Soils:

(1) (Heavy Paddy Soils. Generally long lived paddy.
(Light Paddy Soils. Other crops and second crop possible

(2) Upland "Ya" Lands for general crops.

(3) Inundated "Kaing" lands—submerged in rainy season with silty fertile patches along the rivers.

Crops:

(1)	Whole Year Crops:-	Long Lived Paddy (200 days).
		Cotton, Sugarcane, Pesinngon. Except fo Sugarcane, other crops are sown in early rains.
(2)	Early Rain Crops:-	Short lived paddy (125 t 150 days)
		Early Sesamum, Groundnut (both erect & spreading), Maize - all harvested in 3½ months except spreading Groundnut and soya bean in Shan States. Jute (newly introduced crop).
(3)	Late Rain Crops:-	Some varieties of Paddy, Sorghum, Late rains Sesamum (which differs from early rain Sesamum). All beans and peas (excluding Soya bean). All "Kaing Land" crops, such as vegetables; groundnut and tobacco.

Cropping systems in Burma are essentially the same as those described later in the text under individual crops; a few however, because of the fact that custom and variety vary from the usual, are described as follows:—

Rice (Monsoon)— Nurseries are ploughed in May with onset of rains—ploughing repeated—two or more harrowings—cowdung about 8 cartloads applied. Sow June 45 lbs to 60 lbs per acre—thickly broadcast by hand — transplanting in August, usually in 45 days—spacing 6'x6' to 18'x18' average 8'x8' from seedling stage water is let in up to the time of ripening in November.

Winter Rice — Mayin—Often called summer rice in inundated areas.

Summer Rice— Maukti—Often called spring rice and sometimes known as summer rice.

Early Sesamum— Repeated harrowing and clearing in most areas but plowing is also done before harrowing—sow in June or May if possible 3-5 lbs per acre about 6 inches apart broadcast—no transplanting or watering. In broadcast fields thinning by harrowing is done—up to 2 hand weedings are given. The soil in May is usually dry in Sesamum growing areas of Upper Burma—sow 1½ ft rows and 6' apart—very little cultivation—sow in line.

Late Sesamum—Usually ploughing precedes harrowing because then there is good moisture-in-the-soil to work—sow in late-September or early October 3-5 lbs per acre about 6 inches apart broadcast.

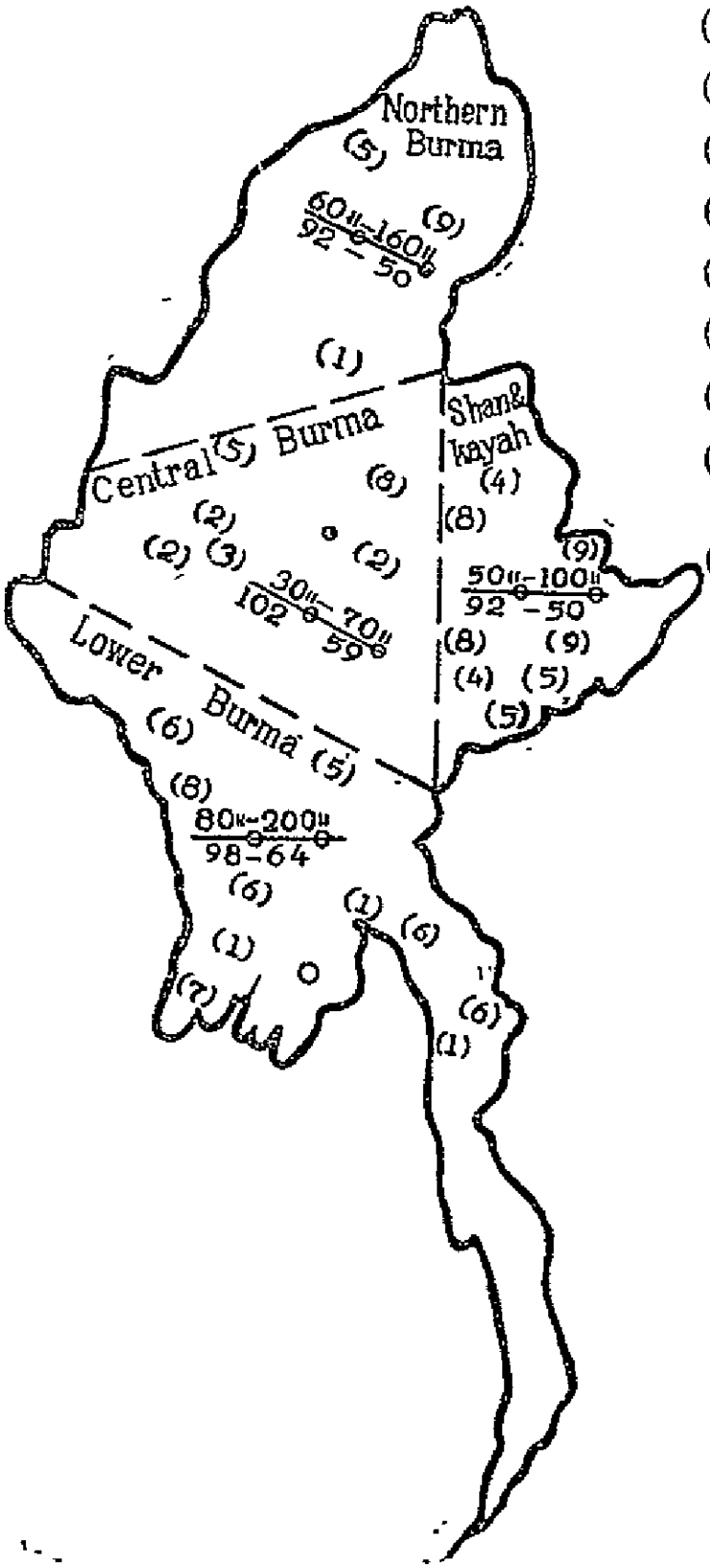
Other Major Crops — Groundnuts—erect and spreading types, Potatoes—sweet potatoes, Vegetables—Brinjal, Lady Finger, Rozelle, Radish, Gourd, Cucumber, Mormordica, Chinese Sweet Potato, Chillies, Onion, Wheat, Pesinngon, Cotton, Wagale (cotton), Sorghum, Maize, Tobacco, Beans — (not vegetable), Sugarcane.

Climatological Summary

—— 5—44 Year Records——

Av. Rainfall (Inches)

Reg.	Max	Min	Ave	Maximum Altitude (ft)	Temperature oF Max	Min
1.	272.7	146.2	203.0	41	85.5	69.8
2.	69.2	25.2	43.7	238	—	—
3.	96.5	55.7	76.8	3536	88.2	59.9
4.	87.9	42.3	64.8	1984	89.8	71.2
5.	140.0	85.4	109 3	4712	—	—
6.	55.5	34.2	44.5	2714	—	—
7.	110.1	76.7	85.2	654	88.7	72.3
8.	224.6	145.3	179.4	153	84.0	76.7



(1) Rice
(2) Rice Irrigated
(3) Dry Zone Crops
(4) Grassland
(5) Monsoon Forest
(6) Evergreen Forest
(7) Mangrove Swamp
(8) Mountain Grass Forest
(9) Above 3000 feet

Nos" = Annual Rainfall (Max-Min)

Nos° = Temperature (Max-Min)

CHAPTER 3

Fertilizers

The use of fertilizers under tropical conditions becomes of greater importance each year as the use of tropical crops becomes more wide spread throughout the world. For practical reasons and for the discussion in this chapter the subject will be broken down into 2 categories, organic and inorganic fertilizers.

Organic fertilizer: This is the best known and the most universal fertilizer in the world. In the form of manure it has been used since prehistoric times and will continue to be used so long as the barnyard animal remains on the farm. The value of manure depends on four important factors:

1. The type of food consumed by the animal (concentrates produce the richest manure.)

2. The species of animal — See table. (Part 1 Chapter 1)

3. The age of the manure — old, well-decomposed manure contains more readily available nutrients than newly made manure.

4. Method of storage—Manure not stored under a roof or at least properly piled in a watershed form, rapidly loses its strength and may be worth little more than straw after a few months.

Manure should be applied and plowed under prior to seeding (1 month if possible). Normally manure is applied at the rate of 15 to 20 tons per acre but for horticultural crops the application may be as high as 40 tons.

The amount of manure produced by barnyard animals varies of course with the size of the animal. For example, one adult cow will produce about 6 tons of dry manure per year. The same animal will produce 900 gallons of urine which is highly important and should be collected and saved. One sheep will produce about one ton of manure and 25 chickens will produce one ton. Chicken manure, unlike that of cattle, is extremely "hot" and strong and must be used with extreme caution. A thousand pounds per acre is adequate as compared with 40,000 pounds of cow manure. For relative strengths of various manures see useful tables. A ton of manure contains 12–16 pounds of nitrogen, 4-8 pounds of phosphoric acid and 10 to 16 pounds of potash. It should be remembered that manure will lose from 13 to 40% of its nitrogen if not properly stored in a pit or shed.

Another form of organic fertilizer is "compost" which is composed of waste organic material such as grass, weeds, crop trimmings and other residues stimulated into a state of decomposition by the addition of water and manure if available. High acidity can be controlled by the addition of wood ashes or lime. Under tropical conditions the compost should be ready for application within two months' time. Temperate zones require more time. Shrinkage to be expected from the original pile will amount to from 45 to 65 per cent.

Green manure is perhaps the easiest way to fertilize land and one of the least expensive in temperate zones. Under tropical conditions some doubt has been raised as to its usefulness as a practice. If manure or commercial fertilizers are not available then it should be used. The method recommended is to grow a heavy leguminous crop such as crotalaria, pigeon pea or desmodium, etc. and plow it under. (Large seed—40 to 50 pounds per acre and plow under just before maturity).

Recommended leguminous green manure crops follow:

Calopogonium mucunoides — vine, legume.

Canavalia ensiformis — Jack bean—vigorous vine—seeding rate up to 150 lbs per acre.

Centrosema plumieri — vine — seed 3 pounds per acre in rows 30 inches apart.

Crotalaria spp. — bushy herb, seed 50 pounds per acre.

Desmodium canum — Spanish clover — low bushy growth — seed 3 pounds per acre.

Dolichos spp. — perennial herb, shade-loving spp. bifolius — annual for dry climates.

Indigofera spp. — spreading to bushy herb — plow in rows 30 inches apart or broadcast. May be toxic to cattle.

Lespedeza spp. — Japanese clover — perennial or annual, sub-tropical, excellent feed — sow 20 lbs per acre for turning under.

Leucaena glauca — a woody bush of rapid growth, sub-tropical — good forage.

Medicago sativa — alfalfa — sub-tropical perennial — high altitudes. Sow 10 lbs per acre — forage and green manure.

Mimosa pudica — sensitive plant, erect woody perennial, common in all parts of the tropics.

Mucuna aterrima — Bengal bean—an erect vigorous grower, very tolerant of high moisture — sow 160 lbs per acre for green manure.

Pueraria phaseoloides — Tropical kudzu, perennial vine, vigorous and palatable to livestock — sow 5 lbs per acre.

Sesbania spp. — Annual of rapid growth and tolerant of high moistures — tall, up to 6 ft.

Stylosanthes guianensis — Townsville clover — erect perennial, one to two feet — resists drouth.

Tephrosia candida — a bushy plant growing 6 to 8 feet tall — sow in rows 40' apart 10 lbs per acre.

Trifolium Alexandrinum — Bersim clover — best in high altitude — does not withstand cold weather.

Inorganic or chemical fertilizers: — These are commonly divided into six categories as follows:

1. Nitrogenous — Ammonium Sulphate, Nitrate of Soda etc.

2. Phosphatic — Super Phosphate, Ground Phosphate, etc.

3. Potassic — Sulphate of Potash, Muriate of Potash, etc.

4. Compound — Mixtures of 2 or more of above.

5. Amendments—Lime, Calcium Sulphate, etc.

6. Minor elements — boron, copper, zinc etc.

The nitrogenous fertilizers vary in usefulness as well as in value and some attention should be given to their selection.

Ammonium Sulphate has an acid reaction and is best used on non-acid soils unless it is used with — lime — neither should it be used on legumes. It contains 21% nitrogen.

Nitrate of Soda contains 15.5% nitrogen and is highly soluble in water — should not be used in mixed fertilizers.

Calcium Nitrate contains 13% nitrogen and absorbs water rapidly. Not recommended for mixed fertilizers.

Calcium Cyanamid contains 20% nitrogen — is slow acting.

In general nitrogenous fertilizers should be applied while the crop is growing and not in the seed bed. Application rates vary between crops but generally fall between 200 and 600 lbs per acre. This is usually spread over the growing season especially where more than 200 pound applications are used.

The phosphatic fertilizers are more difficult to use because of their wide differences in *available* phosphate content.

Super Phosphate contains 18% P_2O_5 soluble in water and the triple super phosphate contains 45% soluble P_2O_5. Phosphates in tropical soils are generally low and legumes invariably respond to treatment. An application of 200 to 400 pounds of triple super phosphates is sufficient for the average crop. This quantity should be doubled for ordinary super phosphates.

Basic Slag contains from 6 to 20% P_2O_5 and is not used much in the tropics — requires from 500 to 15,000 pounds per acre.

Rock Phosphate — ground phosphate rock may run as high as 75% tri-calcium phosphate—slowly water soluble and requires 500 to 1,500 pounds per acre. Seldom used in the tropics.

Potash is used in various forms and is usually required by most tropic soils. Some of the best known forms are:

Muriate of Potash — 40 to 60% K_2O. High priced and used on expensive crops. Use one hundred to three hundred pounds per acre.

Potassium Sulphate — 48% K_2O. High priced and used on expensive crops. Use one hundred to three hundred pounds per acre. Not generally used in the tropics.

Mixed or compounded fertilizers usually are sold under a trade name and contain one or all of the three essential elements, i.e. Nitrogen, Phosphorus and Potash. These are always indicated in that order on the bag as 10: 10: 5 or any other combination of percentages (10% Nitrogen, 10% Phosphorus and 5% Potash). There are many trade names under which mixed fertilizers are sold but for the sake of economy most farm operators buy the bulk ingredients and add only the amount of each that is required.

The need for minor elements is high under tropical conditions and is usually apparent in leaf discoloration and leaf distortion on citrus, avocado, corn and other crops. The most common deficiencies are iron, manganese, magnesium, copper, zinc, boron, cobalt and sulphur. It usually requires a specialist to diagnose the deficiency. The cost of these minor elements and the amount needed per application is small but no crop should be neglected.

The last classification is that of soil amendments. This is not usually important in the tropics but should be mentioned. For example, highly acid soils can be reduced to neutrality by the addition of lime, or alkali conditions may often be corrected by the use of gypsum (calcium sulphate.) In either case large quantities are needed to make the necessary correction.

Bone meal should be mentioned because it is so often misused as a fertilizer. This product is nothing more than dried bones, ground and sometimes steamed. It furnishes calcium and phosphorus, nothing more. Steamed bone meal furnishes phosphorus in readily available form and raw bone meal slowly available. The product is too expensive to use except on small plots and in nurseries.

CHAPTER 4

Plant Pest and Disease Control

This chapter because of its complicated nature must of necessity touch only the most salient points, but at the same time, will have enough general information to take care of the most urgent needs. First of all it should be remembered that in many cases there would be no need for pest control if the plants were maintained in vigorous, healthy condition. This of course is just a matter of maintaining optimum conditions for the growth of the plant, i.e. proper management, fertilization and watering. A weakened plant is an invitation to pests and diseases, the same as with humans or other organisms.

Prevention of pest invasions and diseases among plants can best be carried out by sanitation. Fallen fruits, leaves, limbs, and other debris are a source of continued disease infection and insect infestation. Such material should be collected and burned if a compost heap is not in the making. This should be done at frequent intervals. Light pruning or adequate spacing to allow for sunlight and aeration will help also to reduce disease. Natural enemies of pests should be encouraged and protected and may be carried even further by bringing in natural enemies to combat insects and disease. (Biological control) All these measures will reduce to a minimum the need for chemical control and reduce considerably the costs of operation.

As pointed out above, the main insect pests attacking tropical vegetation are:

1. **The Chewing Insects** — chew and digest green portions of the plant or its fruit — controlled by stomach poisons such as lead arsenate, calcium arsenate, rotenone and Paris Green.

2. **Sucking Insects** — pierce the surface of the plant and suck the juice or sap. Control requires a body contact poison such as nicotine sulphate, pyrethrum, rotenone, DDT, chlordane, parathion and malathion.

Diseases affecting tropical plants fall into three groups: fungus, bacterial and virus. Fungi and bacteria are readily identified by the lesions, spots and wilts left on the leaves and stems of plants attacked. The usual control is by means of fungicides, such as Bordeaux Mixture, lime and sulphur, fixed copper and such trade named chemicals as Zerlate, Delthone, Fermate and others. The old standby "Bordeaux" is still much in use and recommended.

In cases where diseases enter through the roots only, resistant varieties can be considered as a control. Viruses fall in this category although they may enter the plant through the seed or through breaks in the bark. Destroying the plant is recommended. See table (Useful Standards).

Other pests which abound under tropical conditions are soil nematodes (microscopic worms) which are controlled by soil fumigation with DD or EDB, slugs and snails killed with poison bait made of bran molasses and arsenate of lead. Additional pests are bats and rats which can be controlled with Warfarin.

Common plant diseases, symptoms and control may be found in the following summary.

Common Plant Diseases In The Tropics — Symptoms And Control

Disease	Symptoms	Control
Black rot (Pseudomonas)	Plants dwarf, leaves turn yellow and brown; veins become black. Entire head decays into an odorous mass.	Avoid successive plantings on same ground. Use disease-free soil in seedbeds, or disinfect soil. Destroy diseased plants as soon as possible. As the bacteria can be carried in, as well as on, the seed, surface disinfection will not free the seed of black rot infection. Seed grown on the Pacific Coast of the United States is free from black rot.
Blackleg (Phoma)	Brown depressed cankers on stem near soil surface. Circular lightbrown spots may appear on leaves.	Rotate members of cabbage group with other vegetables. Control weeds belonging to cabbage family. As the fungus is commonly carried inside the seed, follow directions for obtaining disease-free seed under "Black-rot."
Downy mildew (Peronospora)	White mold on under side of leaves during cool cloudy weather.	Use bordeaux or copper oxide preparations on young seedlings in seedbed. Spray or dust seedlings with Spergon or spray with Dithane plus zinc sulfate and lime.
Mosaic (a virus disease found mostly on leafy cabbage)	Light and green mottling of leaves.	Rotate crop. Control aphids and weeds.

Common Plant Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Damping-off (Pythium and Phytophthora)	Rotting of seedlings at soil level.	Drench soil with bordeaux; formaldehyde, Spergon. Fermate.
Virus diseases (several types)	Mosaic causes mottling of leaves with light- and dark-green areas, showing some puckering. Spotted wilt may cause the growing point of plant to wilt suddenly, darken and die. There is a bronzing of the upper leaves, with some round spots.	Control insects, particularly sucking types, such as leafhoppers and aphids. Control weeds. Remove affected plants immediately and burn. After handling diseased plants, wash hands with soap before touching healthy plants. Rotate from one area to another in garden. Use resistant varieties.
Bacterial wilt (Phytomonas)	Plants wilt in middle of day and may recover overnight. Wilting becomes progressively worse until plant dies.	Sprays and dusts of no value, as bacteria attack through roots. Rotate crops, omitting pepper, eggplant, and potato as successive crops. Use resistant varieties.
Septoria leaf spot (Septoria)	Spots develop largely on under side of leaves near soil surface and later spread to most of the foliage; development most rapid during rainy humid weather. Dots or grayish mold on under surface of leaves.	Spray with tri-basic copper sulfate, bordeaux, or cuprous oxide, or dust with tri-basic copper sulfate or copper lime dust.

Common Plant Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Early blight (Alternaria)	Spots on leaves, developing concentric rings, with characteristic brownish color. Similar spots on stems can attack fruit at stem scar: Develops rapidly in wet weather.	Spray with bordeaux, tri-basic copper sulfate, Zerlate, or cuprous oxide, or dust with cuprous oxide, copper lime, tri-basic copper sulfate, copper oxychloride sulfate, or Zerlate.
Late blight Phytophthora)	Large water-soaked areas appear on leaf margins. Mildew-like white growth on under side of leaves. Leaves may turn brown and dry rapidly. Development is fast during cool moist weather.	Spray with bordeaux 5-5-50 at weekly intervals.
Damping-off Fusarium wilt	Attacks root, causing plant to wilt and eventually collapse. Stems show darkened areas near surface.	Rotate crop. Use resistant varieties. Sprays and dusts of no value.
Leaf mold (Cladosporium)	Olivaceous areas on lower surface of leaves, yellow discoloration on upper surfaces. Causes defoliation. Very severe.	Bordeaux or organic fungicides must be applied to lower surface of leaves.

Common Plant Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Cercospora leaf spot (Cercospora)	Yellowish-brown spots on leaves, with concentric rings, white centers.	Spray with bordeaux or copper oxide. Dust with copper lime, copper oxide, Zerlate or Fermate.
Anthracnose (Gloeosporium and Colletotrichum)	Fruit spots and rots. Severe, especially during rainy weather.	Spray or dust with Zerlate or Fermate. Copper sprays are less effective.
Blossom-end rot (a physiological disorder associated with water supply)	Blossom-end of fruit showing small to large sunken, dark-brown or black areas.	Provide a uniform soil moisture supply Sprays and dusts of no value.
Nematodes	Minute worms in roots, causing bulging, knotty roots.	Use nematode-free soil. Disinfect soil with fumigants such as D-D or chloropicrin. Dusts and sprays of no value. Rotate with unsusceptible crops.
Bacterial wilt or brown rot (Phytomonas)	Plants wilt only during hottest part of day at first; later, wilting becomes severe and plant dies. Brown areas develop in stems, roots, stolons, and tubers. Bacteria ooze from cut parts.	Plant disease-free seed of more resistant varieties, such as Katahdin. Disease partially controlled by use of sulphur in summer and lime in fall

Common Plant Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Virus diseases (leaf roll, mild mosaic, spindle tuber).	Rolling of leaves and lighter shade of green; mottling and crinkling of leaves; stunting of plants; slender upright growth with darker green foliage Tubers spindle-shaped.	Use certified seed. Control insects, especially aphids.
Rhizoctonia canker, or black scurf (Corticium)	Sprouts die before they emerge; side branches develop and may also have their tips killed. Brown cankers form on sprouts and stolons. Leaves often roll, small potatoes form in axil of leaves. Hard, black bodies adhere to skin of tubers.	Use disease-free seed in clean soil. Disinfect badly diseased tubers by dipping in organic mercury compound or soak for 1-2 hours in mercuric chloride (corrosive sublimate) solution, 4 ounces in 30 gallons. water. Do not use a metal container.
Scab (Actinomyces)	Circular or irregular corky areas develop on surface of tuber. Also pits may develop on tubers. Usually less severe in acid soils.	Use certified disease-free seed or plant in uninfested soils. Treat infected seed as for Rhizoctonia.
Bacterial ring rot (Phytomonas)	Stems wilt with mottling of leaves. Bacteria ooze from cut stems and vascular area on stem end of tubers. Tubers decay	Use certified seed. Disinfect all equipment and containers used to handle potatoes.

Common Plant Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Wilt (Fusarium or Verticillium)	Plants wilt slowly or suddenly, depending on climatic conditions. Stems show darkened areas near surface. Lower leaves may turn yellow and fall off.	Plant disease-free seed and rotate crop with plants other than tomato or pepper.
Mosaic	Leaves show mottling in color, and crinkling and puckering, caused by a virus carried by leafhoppers and other sucking insects.	Control leafhoppers with DDT. Control weeds and destroy diseased plants immediately. Use disease-free seed or resistant varieties.
Powdery mildew	White powdery moldy areas on leaves.	Dusting or spraying with sulphur, bordeaux mixture, or copper oxide may help check disease.
Rust (Uromyces)	Raised reddish dots on stems, leaves and pods.	Common bush green bean varieties are usually resistant. Dust or spray with sulphur, beginning when plants are young. Use resistant varieties.
Leak (Pythium)	Fruits rot in field or during shipment, exuding juice.	Remove from containers all fruits showing signs of the disease.
Leaf spot (Cercospora)	Brownish spots on leaves. Tops may be completely destroyed, but reappear and a good crop is produced.	Apply cuprous oxide or bordeaux spray at 10 day intervals, particularly during rainy weather, after disease has appeared. Furrow irrigate where possible.

Common Plant Diseases In The Tropics — Symptoms And Control *(continued)*

Disease	Symptoms	Control
Soft or root rot (Bacillus)	Outer par of roots affected.	Use raised beds in wet areas and provide good drainage and spacing of plants. Rotate crop where possible.
Smut (Ustilago)	Distorted kernels filled with black powdery spores.	Plant clean seed. Rotate crops.
Leaf spot (Helminthosporium)	Dark elongated spots which may spread and kill leaves.	Use USDA-34 sweet corn or other resistant varieties
Rust (Puccinia)	Dark powdery pustules on leaves.	No control usually necessary.
Leaf-spot (Alternaria sp. and Macrosporium sp.)	Leaves show small round brown spots with purple and red borders.	If serious spray with cuprous oxide or bordeaux mixture, repeating at weekly intervals. Dust with cuprous oxide, bordeaux, or copper lime. Allow plenty of space between plants. Irrigate by furrows when possible.
Damping-off (Pythium)	Young seedlings show water-soaked constriction of stem and lopping over of tops.	Pre-soil treatment — boiling water or Formaldehyde. After-emergence treatment — dust with "Semesan" or copper oxide.
Scald	Rotting at base of plant near surface of ground.	Physiological. Avoid excessive watering.

Common Plant Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Mold (Aspergillus sp.)	Black mold attacks flowers, causes rotting of young fruits.	Bordeaux mixture at weekly or 2-week intervals reduces damage, which appears mostly during wet weather.
Purple blotch (Alternaria)	Small white, large purple, or violet spots on leaves and flower stalks. Much destruction of plants results.	Colloidal copper dusts (cuprous oxide, copper lime, tri-basic copper sulfate or copper oxychloride).
Stem canker	Cankers at base of trunk, causing eventual wilting and death of plants.	

CHAPTER 5

Animal Pest and Disease Control

This subject must be treated superficially because when the life of an expensive animal is at stake, the advice of a specialist should be sought. There are, however, some standby emergency treatments which can be used safely, and treatment for external parasites is standard.

External parasites most common to barnyard animals are the mites, lice, ticks, house flies, mosquitoes and biting flies. The best remedy for these is to keep the animal well oiled and also sprayed with DDT, Malthion or Rotenone. If these are not available, such old standbys as sulphur, lime sulphur, and soap and kerosene are helpful Semi-external parasites such as the skin fly, the heel fly, the nose fly and screw worms can best be treated with:

1. Skin fly — Soap and rotenone solution.
2. Heel fly — „ „ „ „
3. Nose worm — Tobacco solution in the nose.
4. Screw worms — Pine tar or a few drops of chloroform.

Specific diseases, symptoms and control appear at the end of the chapter; also see tables (Useful Standards).

Useful Remedies

These remedies are not intended to be replacents for modern drugs but are given here as ergency remedies, pending the procurement of an equate prescription or a veterinarian.

Astringents (To stop bleeding)

1. Tannic acid
2. Alum
3. Zinc Sulphate
4. Copper Sulphate

) Apply as lotion — one part of chemical to six parts of water by weight.

5. Ground in equal parts, mixed and applied directly as a powder — (a) alum (b) zinc sulphate (c) iron sulphate.

Disinfectants

1. Solution 4% sodium carbonate by wt. in water.
2. „ 5% fenic acid (carbolic acid) in water.
3. „ 1 part by wt. perchlorate of mercury in 500 parts water.
4. „ 5% lysol or cresol.
5. „ 100 parts by wt. of slaked lime, 15 parts of carbolic acid mixed together.
6. „ 1 part by wt. of potassium permanganate in 300 parts water.

7. Powdered slaked lime.
8. Solution of 10% ammonium hydroxide in water.
9. Solution 40% formaldehyde in water.
10. Sulphur smoke.

Antiseptics

Lotions

1 2.5% fenic acid (carbolic acid) in water.
2. Tincture of iodine.
3. Perchlorate of mercury — 1 part in 1000 parts water.
4. Kerosene
5. Turpentine
6. Pine Tar
7. Boric Acid solution 5% in hot water (for eyes)

Powders

1. Sulpha powders and salves
2. Penicillin powders and salves
3. Zinc oxide 1 part; boric acid 1 part; starch 2 parts.
4. Antibiotics.

Liniments — Sprains and muscle aches and bruises.

1. 10 parts of vegetable oil and 1 part fenic acid.

2. Turpentine 8 ounces, creosote 2 dracmas, mineral or vegetable oil 12 ounces.

3. Patented linaments.

Salves — Irritations caused by insects, etc.

1. Sulphur 1 oz, vaseline 9 ounces.

2. Mecoxic iodide 1 part, Vaseline 7 parts.

3. Various patented salves.

Purgatives

1. Epsom Salts (Magnesium sulphate)

2. Castor oil or mineral oil

3. 1 pound of Epsom salts, 1 oz powdered aloes, ½ oz ginger, 2 pints of water.

Anthelmintic — Control of worms

Stomach and intestinal worms of barnyard animals are best controlled by having the animals live under clean sanitary conditions, but if infestations do occur, effective drenches can be prepared:

Phenazine — a dispersible powder which can be mixed with food (pigs and fowl) or mixed with water and used as a drench for cattle and horses — it may be purchased also in pill form. Dosage:

(Young calves) ¼ to ½ oz — (Heifers 6 mo. of age) 1½ oz to 2 oz — (Adult animals) 2 to 2½ oz — (Sheep & Goats, 6 mo. of age) 1/6 to 1/3 oz — (Adult animals) ½ to 1 oz — (Hogs, Young Pigs) 1/3 to ½ oz — (Adult animals) 1 to 1½ oz —(Horses) same as for sheep.

Nicotine and Copper Sulphate — Prepare solution as follows: 1 lb 4 oz of copper sulphate crystal; 1 pint of 40% nicotine sulphate; 2½ gallons of water; 12 drops of hydrochloric acid. Dosage: 4 ozs for calves up to 12 mo. and 8 ozs for adults—¼ to ½ oz for lambs and 1 oz for adults. (If nicotine sulphate is not available make up the solution without it — same dosage).

Treatment for round worms is accomplished as follows :

Linseed oil and Turpentine — Calves — one to two tablespoonsful of turpentine mixed with 2 - 4 oz of unrefined linseed oil, give this amount 2 successive nights.

Oil of Chenopodium — for large round worms in hogs, give 1 tablespoonful of oil of chenopodiun in 5 oz. of castor oil, per 100 lbs of weight on an empty stomach.

Sodium Flouride — Round worms of Hogs — give 0.1 to 0 15 grams of 75% pure sodium flouride for each pound of live weight. Mix with feed. For example, 4 hogs weighing 400 pounds (0.15 grams per pound per animal) would require 60 grams for the four animals or 15 grams for 1 animal weighing 100 pounds.

Commonly known medicines

Inexpensive medicines which should be on ınd at all times and which are used in formulas :scribed above and others are:

1. Acriflavine
2. Alum
3. Ammonium Hydroxide
4. Camphor
5. Fenic Acid
6. Castor Oil
7. Chinosol
8. Chlordane
9. Chlorox
10. Chlorine Powder
11. Coconut Oil or Vegetable Oil
12. Copper Sulphate
13. Croton Oil
14. Balsam
15. Pine Tar
16. B.H.C
17. Ginger Powder
18. Iodine Solution
19. Iron Sulphate
20. Lead Oil
21. Linseed Oil
22. Lysol
23. Creosote
24. Epsom Salts
25. Mercuric Iodine
26. Perchlorate of Mercury
27. Mineral Oil
28. Phenazine
29. Potassium Nitrate
30. Potassium Permanganate
31. Unslaked Lime
32. Sodium Carbonate
33. Tar
34. Sulfanilamide
35. Sulphur Powder
36. Lime(slake)
37. Tannic Acid
38. Turpentine
39. Kerosene
40. Vaseline
41. Zinc Oxide
42. Zinc Sulphate
43. Sterile Water
44. Lye Soap

Disease	Symptoms	Control
Actinomycosis and Actinobacillosis (Lumpy Jaw) Actinobacillosis caused by micro organism infecting soft tissues of head and throat. Actinomycosis caused by infection with Actinomyces bovis which generally localizes in bone, usually the jaws. Abrasions or laceration in oral cavity believed to be primary port of entry.	Actinobacillosis symptoms are swellings under skin which can be moved with fingers and may be as large as a walnut or an egg. One or more lymph nodes of neck may be abcessed. Actinomycosis involves large pus filled tracts or cavities in the bone. Fistulas or drain from abcesses sometimes occur in skin or in mouth.	Actinobacillosis may be treated with potassium iodide administered as a drench and local applications of tincture of iodine. Streptomycin intramuscularly and/or locally for several days has given good results. Surgery indicated in some cases.
Anaplasmosis — Caused by Anaplasma marginale, a protozoan which infects and destroys red blood cells. Probably spread by sucking insects.	Sudden loss of condition, increased pulse and breathing. Pale or yellow mucous membranes, drooling from mouth, discharge of thick mucous from nostrils, progressive weakness, cessation of rumination and defecation. Severity and duration of disease varies. Animals may die within 24 hours or slowly recover.	Isolation of infected animals. Blood transfusion and antibiotics helpful in chronic form of disease. Calfhood inoculation with mild strains of parasites practiced in some localities.

Disease	Symptoms	Control
Anthrax – Caused by Bacillus anthracis, a spore forming bacteria. Spores highly resistant to heat, low temperatures and disinfectants. Retain viability for years in soil, water, hides or contaminated objects. Spread through infected animals and objects associated with animal life. Incubation period varies from 24 hrs. to 5 days or longer.	In peracute form characterized by fever, sudden staggering, difficult breathing, trembling, collapse and death. In acute form there is a rise in body temperature, period of excitement followed by depression, stupor, spasms, respiratory or cardiac distress, staggering, convulsion and death. During course of disease rumination ceases, milk secretion is reduced; swellings may appear in different parts of body and bloody discharges may emanate from natural body openings.	Annual vaccination of cattle in anthrax districts by means of anthrax anti-serum, bacterin or living spore vaccines is effective method of prevention. Penicillin and Terramycin have been effective in treating animals showing early symptoms. Control includes strict quarantine. Disposal of dead animals by cremation or deep burial under quicklime. Burning of manure; bedding and other contaminated material. Isolation and treatment of sick animals. Vaccination of exposed animals. Disinfection of contaminated stables and equipment and change of pasture.
Blackleg — Caused by infection Clostridium chauvoei, most commonly attacks calves between 4 months and 2 years of age. Spores	High fever, formation of gaseous swellings under the skin, especially on hind quarter or shoulder. Swellings cause stiffness or lameness, swellings first are small, hot and painful —	Vaccination with blackleg bacterin is effective method of immunizing calves. Treatment with antibiotics have given good results in cases with early symptoms. Control measures include isolation of infected animals, vaccination of exposed calves, disposal of dead animals and contaminated material by burning

Disease	Symptoms	Control
Blackleg (*continued*) survive in soil of pasture for a number of years. Believed that germs gained entrance to body through small punctures of mucous membrane of the digestive tract or through wounds in the skin.	later are large, cold and painless. Loss of appetite, suspension of rumination, rapid breathing and depression. Most affected animals die in 12 to 36 hours.	or deep burial and disinfection of contaminated stables.
Bloat -- Caused by the rapid fermentation of such feeds as clover, alfalfa, frozen roots, decayed vegetables. Choke will cause this affection.	The paunch fills with gas, causing a marked swelling high up in the left flank accompanied by difficult breathing and distress. If relief is not given, death may shortly follow.	Accustom cattle to green feed gradually. Give animals a good feed of dry roughage, before they are turned on clover or alfalfa pasture. Avoid decayed or frozen food of any kind. As a last resort in severe cases provide artificial outlet for gas by means of trocar and canula inserted through the left flank into the paunch. In moderate cases give two tablespoons of turpentine or other antiferments in one qt. of warm milk or water as a drench. Keep cattle from dewy clover or alfalfa.

Common Livestock Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Bovine Coccidiosis — Caused by a parasite protozoa. Usually affects calves between 3 weeks and 6 months of age. Occasionally attacks mature cattle. Infection occurs by swallowing of oocysts.	Rough coat, weakness, listlessness, nervousness, poor appetite, diarrhea, loss of weight or poor gains in weight. Diarrhea may contain strands of gelatinous mucous and splotches or streaks of blood.	Control consists of segregation of calves into 3 or 4 age groups and separation of the calf from its accumulation of manure by wire mesh or slat floors or by portable pens. Treatment with sulfas.
Brucellosis (Bang's Disease—Abortion)—Caused by Brucella abortus. Infection usually takes place by ingestion of feed, water or other material contaminated by afterbirth, discharges, or fetus from infected animals. Incubation period from 7 days to 7 months or longer.	Abortions, birth of weak calves, retained placentas, abnormal vaginal discharge, temporary or permanent infertility.	No successful treatment. Controlled by means of vaccination of calves from 4 to 8 months; disposal of reactors as indicated by blood tests, and purchase of clean replacements.

Common Livestock Diseases in The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Calf Scours—Caused by a variety of infectious agents which enter body by ingestation, inhalation or through umbilical stump. Result from overcrowded conditions, poor hygiene and poor diet for the calves or their dams.	*Calves have fetid white watery* diarrhea soon after birth. Weakness and poor appetite. Calves may die suddenly.	*Good feeding management and sanitation practice.* Treatment of outbreak of scours is serious problem but antibiotics often helpful.
Foul Foot and Foot Rot—Caused by wedging of filth between the claws. Claws become too long. Bruises.	Lameness, heat and swelling above the hoof, foul odor and pus accumulations beneath the horn.	To prevent, keep the feet clean and provide exercise on well drained ground. Soak feet in 2% coal tar disinfectant. If pus has burrowed beneath the horn trim away overlying horn to allow drainage. Apply local antiseptics and sulfas or antibiotics systemicly.
Malignant Edema — A wound infection caused by spore forming Clostridium septicum. *First symptoms usually* appear 12 to 72 hours after infection enters body.	Hot, painful swellings at point of infection. High fever, loss of appetite, drop in milk secretion, severe depressions, difficult *breathing and convulsions.* Most animals die one or two days after symptoms appear.	Danger can be reduced by giving prompt attention to punctures and penetrating wounds. Can be transmitted to man and suspected cases should be handled with rubber gloves. Control measures include vaccination of exposed animals, prompt disposal of carcasses and bedding by deep burial, disinfection of contaminated stables. In districts where soil is contaminated animals should be vaccinated before being placed on pastures. Antibiotics are of value if administered during early stages.

Common Livestock Diseases In the Tropics —Symptoms And Control *(continued)*

Disease	Symptoms	Control
Mange (Scabies) — A contagious skin disease caused by minute parasitic mites—4 kinds parasitic to cattle.	Psoroptic mites attack hairy parts of the body, generally begin infestation over withers and more sheltered parts of body. Chorioptic scabies usually begin on inside surface of hind legs. Sarcoptic mites may produce lesions anywhere on the body. Hairless spots appear, dandruff is abundant, blisters form, and skin may become thickened, hard and covered with crusts or scabs. Skin may crack and ooze blood and pus. Demodectic mange takes the form of nodules in the region of the neck, shoulders and brisket.	Treatment consists of dipping and spraying with solutions of benzene hexachloride, lindane or toxaphene. Beef cattle should not be treated within 30 days of slaughter. The above treatment should not be used on lactating dairy cows.
Mastitis (Garget)— Inflammation of the udder resulting from infection with various kinds of bacteria or yeasts.	In acute mastitis, affected quarter is hot, hard and tender. Milk secretion is largely suspended. Milk may be watery, straw colored, blood tinged and contain clots or lumps. Depression, fever and loss of appetite	Control includes detection by use of strip cup or tests and prompt treatment with udder infusions containing antibiotics, sulfonamides or nitrofurazones. Milk from infected quarters should not be used for at least 72 hours following treatment. Systemic treatment with antibiotics often helpful in severe or persistent cases. Proper milking and

Common Livestock Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Mastitis (*Continued*)	may occur. In chronic infections there may be little or no swelling and flakes or clots may or may not appear in milk.	udder sanitation procedures as outlined in section on milking should be followed.
Milk Fever—Non-contageous metabolic condition occurring in high producing dairy cows, usually 4 to 9 years old, the first few days after calving. Symptoms caused by deficiency of calcium in the blood.	Dullness, reluctance to move may occur in early stages. Excitement, tetany or spasms of hind legs. Paralysis begins to affect hind legs, cow staggers and goes down. Head and neck are kinked laterally or turned back alongside.	Treatment is intravenous injection of calcium gluconate in 20% solution. Cow down with milk fever should be kept on her *sternum to prevent* pneumonia and bloating.
Paratuberculosis (Johne's Disease) — Caused by bacillus Mycobacterium paratuberculosis. Spread through droppings. Incubation period usually a year or longer. Symptoms mostly seen in animals 2 to 6 years old.	Persisent or recurring diarrhea with fetid odor, which does not respond to usual treatments. Rapid loss of flesh, unthrifty appearance. Milk flow drops or stops entirely. Normal temperature. Animals showing symptoms usually die in a month to 2 years.	No successful treatment of Johne's Disease. Con*trol consists of locating reactors by* johnin tests and isolation of clean from infected animals.

Common Livestock Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Pink Eye or infectious Keratitis — Cause not definitely established. Disease spread by transfer of secretions from eye of affected animal to normal susceptible animal	Eyelids swell, discharge watery at first, later contains mucus and pus. Lining of lids becomes red and congested. Often pink or red ring surrounds white part of eyeball. Eyes are closed showing evidence of pain. Eyeball becomes cloudy and animal may be unable to see for several days. Ulcers may form in front of eye near pupil, sometimes eyeball is destroyed. Milk flow drops, animals lose weight because they cannot find their way to feed.	Mild antiseptic eyewashes and antibiotics valuable in individual cases. Control insects. Vaccination is often helpful.
Rabies — Caused by a virus. Spread through the bite of a rabied dog, foxes and other animals. Period between bite and appearance of symptoms may be 14 to 285 days.	Restlessness, viciousness, paralysis, loss of appetite, milk secretion stops, manifestations of fear, violent behaviour. Dies 1 to 6 days after first symptoms.	No treatment. Control measures include vaccination and restriction of dogs. Control wild animals in known infected areas.

Common Livestock Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Roundworms - Parasites of the Digestive Tract. Caused by a variety of species of stomach and intestinal parasites. Infection usually occurs by swallowing larvae. Eggs are passed with feces of infected animals.	Symptoms vary with infecting organism but anemia as shown in paleness of mouth and eyes, weakness, stunted growth, rough hair coat and diarrhea may occur.	Control consists of maintaining proper rate of stocking and rotating pastures. Regular treatment with phenothiazine to reduce worms and number of eggs.
Shipping Fever —An infectious respiratory disease, true cause not established. Symptoms usually appear 5 to 14 days after first exposure. Often occurs following shipping and handling.	Tired appearance, reduced appetite, soft cough. Temperature 103—107°F. Soon becomes depressed and gaunt. Breathing rate increased. Watery discharge from nose and eyes. Some years disease will follow mild course, many cases will recover in a few days, without treatment, other years infected animals may die within 24 hours.	Serum and vaccine has been of some benefit. Avoid subjecting animals to severe stress. Treatment with antibiotics and sulfas useful in alleviating symptoms. Isolate sick animals.

Common Livestock Diseases In The Tropics—Symptoms And Control (*continued*)

Disease	Symptoms	Control
Tetanus — Caused by Clostridium tetani organisms. Spores occur in top layer of soil, especially in old farming areas. Enter body through lesion or wound contaminated with foreign material or soil. Cows may get infection following parturition.	Chewing is difficult, swallowing slow and awkward. Spasms spread rapidly from one group of muscles to another, making them rigid. Death usually comes 7 to 10 days after first symptoms.	Prompt attention to deep wounds and treatment of injured animals with tetanus antitoxin plus antibiotics.
Tuberculosis of cattle—Caused by tubercli bacilli. Bacilli usually enter body by way of mouth in food or water. Sometimes breathed directly into the lungs.	May show no symptoms or a gradual loss of weight and condition. A chronic cough sometimes develops in cattle affected with tuberculosis of the lungs.	Give cattle tuberculin test and dispose of reacting animals. Purchase only clean replacements.
Warts—Caused by a virus. These may appear anywhere on the body, especially on the teats.	Warts are a nuisance but their presence does not interfere with the animal's health.	May be removed by softening with oil or snipping it off with scissors. Infectious type may be treated by injections of vaccine by a veterinarian.

Common Livestock Diseases In The Tropics—Symptoms And Control (*continued*)

Disease	Symptoms	Control
Goiter (Big neck)—Swelling of thyroid gland of calf resulting from lack of iodine in ration of dam during gestation.	A swelling in the neck accompanied by labored breathing in advanced cases due to pressure on the windpipe.	Change of feed and exercise will be found helpful in bringing about recovery in young animals. If the swelling persists paint with tincture of iodine. Give one grain of potassium iodide once a week.
Impaction, Indigestion, Constipation.	A stoppage of the bowels, straining, colicky condition usually present in fevers. Also pains, loss of appetite, sluggishness, caused by faulty feeding.	One to two quarts of warm '*raw*' linseed oil. Care should be taken in its administration not to let it enter nostrils or lungs. (Never use boiled linseed oil).
Swine Diseases		
Brucellosis—Caused by a bacterium Brucella Suis.	Sows: Abortion, sterility or lameness. Sometimes no signs. Boars: Loss of sexual desire, swollen testicles, lameness.	No treatment. Sell infected and blood test periodically. Sanitation.
Erysipelas—Caused by a bacterium Erysipelothrix rhusiopathiae.	Fever, off feed, listless, painful gait, red patches on body. Usually live 5 to 8 days, some die suddenly. Other types involve heart or joints.	Antibiotics alone and antibiotics with a specific immune serum are useful. Vaccination and sanitation.

Common Livestock Diseases In The Tropics—Symptoms And Control (*continued*)

Disease	Symptoms	Control
Hog Cholera — Caused by a virus spread by direct and indirect contact.	5—10 days after contact. A few sicken first. Dull, fever, off feed, many deaths in 5-7 days after first signs. Occasionally sudden deaths.	Serum if very early. Vaccination, sanitation and quarantine.
Lice — A blood sucking parasite.	Scratching and rubbing. Restlessness. Lice on body.	Lindane, Rannel (Korlan) Malthion DDT and toxaphene.
Mange — Caused by mites, commonly Sarcoptes scabiei, var. suis.	Usually starts on head, then legs & body. Skin becomes thickened, rough, dry and scaly and wrinkled Vigorous scratching & rubbing.	Lindane, Rannel (Korlan) Malthion dips, dusts and sprays.
Mastitis — Caused by bacterial invasion of mammary glands.	Loss of appetite, fever, swollen painful udder, milk stringy or absent.	Injections of antibiotics and hot applications to udder. Controlled by cleaning udder prior to farrowing, and providing clean, bedded quarters.

Common Livestock Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Round Worms—Caused by Ascaris lumbricoides.	"Thumping", loss of weight, unthrifty. No signs unless severely infected.	Piperazine salts, sodium flouride, and hygromycin B.
Swine dysentery (Blood scours) Caused by a Virbrio infection of large intestine.	Diarrhea—often bloody or dark and containing mucus. Death losses about 25% — Surviving animals unthrifty. Any age, worse in younger pigs.	Quarantine and isolation. Arsenicals and antibiotics reduce symptoms and death losses.

* Delaval Diary 1962

Common Poultry Diseases In The Tropics — Symptoms And Control

Disease	Symptoms	Control
Chicken Pox — Caused by a filterable virus.	Small scabs on the combs, wattles or skin. Eyes may become involved with an accumulation of cheesy pus; frequently causing the loss of the eye. Disease lasts for several weeks once it becomes established. Losses vary greatly, depending upon whether just the skin is involved or whether the mouth, throat, etc. become affected, which may increase death losses and prolong the outbreak.	Vaccinate pullets with Fowl Pox vaccine when 8—12 weeks of age. In some areas it may be necessary to use Pigeon Pox vaccine, due to serious outbreaks of Blackhead following the use of the Fowl Pox vaccine. There is little, if any, reaction when Pigeon Pox vaccine is used, but the protection is not quite as solid as that produced by the Fowl Pox vaccine. Vaccinate broilers only upon recommendation of the pathologist or veterinarian.
Infectious Bronchitis — Caused by a filterable virus.	A very rapid spreading respiratory disease (cold). A sudden drop in egg production is an early sign of this disease. The egg shells are of poor quality. The egg may have a watery white. Death loss is seldom serious in adult birds. In baby chicks the infection varies from a mild harmless attack to a	In pullets, 6—16 weeks of age, a type of vaccination is practised of exposing a few birds at a laboratory and returning them to the flock. This is done at an age when the uncomplicated disease is relatively mild. No treatment once the disease has spread throughout the flock, except proper care.

Common Poultry Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Infectious Bronchitis— (*continued*)	severe attack with 25 to 90 per cent mortality. Gasping is present in all ages. The course is relatively short and when uncomplicated, a complete recovery occurs.	
Newcastle Disease — Caused by a filterable virus.	Gasping much like Infectious Bronchitis in its early stages and shortly thereafter typical paralysis of the neck muscles, with the head being held at various angles. The muscles of one or both legs may be affected or there may even be almost complete paralysis with a jerky movement of the whole body. This disease may be spread from chick to chick rather easily. Adult birds may only show symptoms of respiratory discomfort with a few paralyzed birds and a complete cessation of egg production within 2 or 3	Vaccination with one of the three types of Newcastle Disease vaccines on the market. Vaccinate according to the manufacturer's directions. No specific treatment, other than to keep the birds warm, comfortable and help feed consumption by use of milk products or any other means available.

Common Poultry Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Newcastle Disease *(continued)*	days after the onset. The egg-shells are thin with a chalky shell, brown eggs will be white and white eggs appear bleached.	
Pullorum Disease (White Diarrhea)— Caused by a bacteria called S. Pullora.	This disease has been reported in chickens, turkeys, some wild birds, and to a lesser degree, in guinea fowl, ducks and geese. The disease is transmitted in most cases, from adult to off-spring through the egg. The greatest loss is in young chicks. The chicks fail to eat, huddle, fail to grow, have a dried up appearance and may have short puffy bodies, which seem nearly specific of this disease. Some have labored breathing, probably due to the formation of abcesses in the lungs. Mortality may vary from almost nil to nearly 100 per cent. Nodules are found in the lungs, liver,	To control this disease a very widespread plan has been developed to blood-test the breeders for this disease and to eliminate the carriers. The National Poultry Improvement Plan describes this procedure in detail. If one is unfortunate enough to buy chicks that have this disease, one may use some of the newer sulfa drugs such as Sulmet, Sulfaquinoxaline, and the like, as directed by the manufacturer to help out down death losses. The sick chicks should also be destroyed and burned or buried at once. They should also be fed an appetizing diet, one containing milk or milk products, where practical.

Common Poultry Diseases In The Tropics—Symptoms And Control (*continued*)

Disease	Symptoms	Control
Pullorum Disease—(*continued*)	heart wall, gizzard, and at times in other organs. An accurate diagnosis must be made from the diseased birds in a laboratory. Some birds remain visibly healthy but are the "carriers" that lay the infected eggs.	
Chronic Respiratory Disease (CRD) Thought to be caused by a pleuro-pneumonia-like organism.	Symptoms include nasal discharge, swelling of face, rales, and coughing or sneezing. Some birds have no signs but have lesions. Introduce only very young birds to area and keep where infection is not present.	No effective treatment but antibiotics in feed or water may be helpful.
Aspergillosis—a fungus disease caused by Aspergillus fumigatus.	In young birds the acute type may occur from contaminated food or litter. The affected chicks have difficult, rapid breathing and gasping. The affected birds refuse to eat, drink excessively become emaciated and many times have	Prevention is useless in individual birds; however, removal of moldy feed or litter is necessary. Spraying the house with an oily substance to prevent dust from flying is helpful. All affected chicks should be destroyed to prevent the spread of the disease.

Common Poultry Diseases In The Tropics—Symptoms And Control (*continued*)

Disease	Symptoms	Control
Aspergillosis—(*continued*)	diarrhea in the later stages. Mortality varies from negligible to more than 50 per cent. When the fungus grows under the third eyelid, a yellowish pellet may be expressed, which has caused a bulging appearance of the eyelid. The eyeball itself may be involved with complete blindness. Adult birds have a soft rattle in the trachae and production drops in the affected individual. Demonstration of the fungus is essential to a positive diagnosis.	
Coccidiosis is the major protozoan infection in the poultry field. This may still be one of the most costly diseases of our entire poultry population today.	This disease is characterized by a loss of flesh, color and appetite. When opened the carcass presents an intestinal tract that is far from normal. The walls are thickened and dilated with numerous gray or whitish spots	Sanitation, such as cleaning the house and the feed troughs, together with the use of a coccidiosis drug treated mash, will control outbreaks. This condition may be prevented by feeding the flock mash with a low level coccidiostat, continuously until broilers are marketed or pullets have developed an immunity to this protozoa. There are many good drugs on the

Common Poultry Diseases In The Tropics—Symptoms And Control (*continued*)

Disease	Symptoms	Control
Coccidiosis — (*continued*)	visible from the unopened intestine. When opened, the intestine usually contains a grayish or brownish thick mucus, at times containing flecks of blood. The affected birds stand in bunches with the heads drawn down, the feathers standing, and have a very dejected appearance. The loss of weight and color are very outstanding in these cases.	market to control this disease, each having its own advantage. Some are marketed under the names of Nitrophenide, Nitrofurazone, Sulfaquinoxaline, and some of the Arsenicals to mention a few.
Infectious Entero-Hepatitis (Blackhead) caused by H. meleagridis.	This is a turkey disease but also affects chickens, especially in some areas where laying pullets develop the disease following vaccination for Fowl Pox. These flocks must be vaccinated with Pigeon Pox vaccine. Affected birds are dull and many times have a dark comb and a diarrhea with a yellowish tinge.	It is a soil borne infection and the parasite is also in the egg of H. gallinae (ceca worm). This disease may be prevented with one of the new drugs or at least arrested by them. These drugs must be used according to the manufacturer's directions.

Common Poultry Diseases In The Tropics—Symptoms And Control (*continued*)

Disease	Symptoms	Control
Lice	These pests are the most widespread external parasites of birds. There are about 10 different species of lice, each affecting different parts of the body. These parasites are spread by contact from bird to bird. They are occasionally found on other animals but do not propagate upon them. These insects are flattened, brownish-yellow, rapid moving insects that cause restlessness, unthriftiness and loss of sleep; thus the infected birds fail to gain weight or lay eggs properly.	There are several methods of control. The one that is practiced on most large groups is the fumigation with nicotine sulphate, 40% solution, painted on the roost at the rate of 8 ounces per 100 ft. just before the birds retire It should be used when the temperature is above 60°F. Another agent is orthophenylphenol; using one-fifth pound per gallon of kerosene and brushed on the roost like the nicotine sulfate. Sulphur can be used to dust birds individually or as a dip, using half ounce per gallon of warm water. Malthion as a 3% solution may be used for painting roosts. A 1% spray may be used for nests and litter. A 4% dust or a 0.5% spray of malthion may be applied directly on birds. Rotenone as a 1% dust may be applied on birds, roosts and nests.
Mites (Red Mite)	These are the most common and persistent of the mites. They may live for several months in a house without food. Mites are blood-suckers which cause an anemia and may transmit viral or bacterial	Control is not too difficult. The house should be thoroughly cleaned and the nests, roosts and crevices painted or sprayed with an anthracene oil wood preservative (carbolineum). Nicotine sulfate or malthion used in the same manner as for lice are effective against mites.

Common Poultry Diseases In The Tropics—Symptoms And Control (*continued*)

Disease	Symptoms	Control
Mites—(*continued*)	diseases. This parasite is very small but has a tremendous appetite. In most cases the pests feed at night. fall off when full and stay in the nests, litter or cracks in the house until hungry again.	
Scaly Leg Mites	This condition is quite widespread especially in older birds. The burrowing parasite causes scales and crusts to be formed on the unfeathered portion of the leg.	Flock treatment is to remove affected birds or treat them individually by dipping in one part kerosene and two parts linseed oil.
Crop Worms	*There are three species of* worms that live in the lining of the crop and esophagus, each burrowing and leaving a tortuous path, seen when the crop is examined closely. *Loss* of weight and general unthriftiness.	Control, of course, is best carried out by breaking the cycle of dropping, to litter, to chicken. Pullets should be raised on a new range each year. Ranges must be left free of chickens for two years if possible.

Common Poultry Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Stomach Worms	Live in the lining of the proventriculus causing a swelling and sloughing. The birds become thin and fail to eat and finally die. The intermediate host is the pillbug and the sowbug which contaminate the water. The birds consume the bugs with the water and incidentally become infected. Loss of weight and general unthriftiness.	Same as for crop worms.
Roundworms of the Intestine.	Ascarids or Roundworms are quite common wherever chickens are grown. The worm is round, white, some types short, some up to two or more feet in length. The worm lives free in the intestine. The worm egg is in the feces contaminating the soil when the droppings are voided. The chicken eats the egg when picking in the contaminated soil or litter. The worm eggs are resistant to low tempera-	Same as for Crop worms. Drug treatment is quite satisfactory for most roundworms. The nicotine or nicotine mixtures used according to the manufacturer's directions are very effective.

Common Poultry Diseases In The Tropics — Symptoms And Control (*continued*)

Disease	Symptoms	Control
Roundworms of the Intestine (Continued)	tures and live in the soil for more than a year. An egg is infective in 10-12 days after ingestion. Birds heavily infested become pale, droopy, emaciated and at times develop a diarrhea. Mortality may be high in young birds; adult birds may fail to lay well.	
Tapeworms	Flattened, ribbon-shaped, segmented, white worms. The adult lives in small intestine of poultry with the head attached. The tapeworm grows from the neck backwards and voids the egg sacs which are the latter segments in the droppings. The intermediate hosts, beetles, flies, snails or slugs consume the egg infested droppings. When the egg has been in the intermediate host 3-4 weeks, it is then infective. Infested birds are pale, thin, unthrifty, have a poor appetite in the latter stages, and production is low.	Control is one of sanitation. Clean the house and yards of all rubbish, manure piles and damp places, to remove the hiding places of the intermediate hosts. Several medicinals are present by being marketed but have rather inconsistent results.

CHAPTER 6

Animal Nutrition

This complicated subject is here reduced to its simplest form. The subject is of so little concern in Burma, as in most other tropical areas, that a simple beginning such as this will be like opening a door into a new world. In this chapter an endeavor will be made to show how essential it is that animals should be properly fed, with but little reference as to the reason. From the foregoing data the agriculturist should be able to figure his own rations with the material at hand. If this cannot be done then he can use those recommended in this chapter with equally good results. First, there are presented in Part I Chapter 1, approximate nutritive values for various feed stuffs, and it is from these that rations for livestock can be calculated, either precisely or approximately.

Feeding -- Dairy Cows

The daily ration needed to sustain the animal for each one hundred pounds of live weight is approximately 2.0 pounds of good quality hay, and for each gallon of milk given (10 lbs) there must be added to the above sustenance ration 2.8 pounds of grain concentrate. This ration should contain approximately 2 pounds of starch equivalent and 0·3 pounds of protein equivalent for each 100 lbs of live weight. Thus a six hundred pound cow giving 30 pounds of milk with 3.5% butter fat would require approximately 20.4 pounds of good roughage, consisting of good legume hay and grain concentrate. Practically, this can come from a daily ration of all the good quality dry hay

(preferably legume hay) that the animal can eat plus a supplement of 9 pounds (3 pounds per gallon) of concentrate feed outlined as follows:

Ground corn	35%
Ground citrus pulp	17%
Rice bran	10%
Ground coconut cake	30%
Ground linseed cake	5%
Minerals — Bonemeal 1%	
lime 1%	= 3%
clodide salt 1%	
Total	100%

Substitutions – Milo or any grain for corn – root crops such as Tapioca with powdered black molasses for citrus pulp – wheat bran or ground oats for rice bran – sesamum cake, soybean cake or cottonseed cake for linseed or coconut.

Feeding—Calves

All the good leguminous hay that will be eaten plus ½ to 3 pounds daily (depending on weight) of the following concentrate mixture:

Ground corn	30%
Rice bran	10%
Fish meal	10%
Dry milk powder	20%
Black molasses	5%
Coconut cake	22%
Mixed minerals	3%
Total	100%

Feeding — Hogs

From the time a piglet is weaned until he weighs 100 pounds, his ration should contain 16 percent protein, 1/3 of which should be of animal origin. Above 100 pounds in weight, the ration should contain 13% protein (all plant). A pregnant sow should have about 7 pounds daily of the following ration plus all the green fodder or pasture she will eat. Without pasture the ration should be increased to eight pounds or more. Nursing sows should have their ration increased by one pound per sucking pig. A good hog ration follows:

Ground corn	10%
Ground wheat	10%
Rice bran	10%
Molasses	10%
Powdered dry milk	5%
Fish meal (optional)	5%
Coconut cake	35%
Dry distillery yeast (optional)	5%
Ground peas	12%
Mineral supplement	3%
Antibiotics	Trace
Total	100%

Substitute soybean meal for fish meal—substitute soybean or cottonseed meal for coconut meal — wheat bran or ground oats for rice bran—milo or similar grain for corn.

Feeding — Laying Hens

For maximum egg production the hen must be provided with a clean fresh supply of water and a complete laying ration continuously present in the

self feeder. Each hen will consume about one pound of ration daily of cracked mixed grains, ground oyster shell, ground bone, gravel and green feed.

A recommended ration for laying hens follows:

Ground corn	30%
Rice bran	12%
Ground oats	12%
Meat meal	6%
Coconut meal	20%
Soybean meal	12%
Distillery yeast	5%
Mineral mixture	3%
Cod liver oil (1 pt per 100 lbs)	
Antibiotics	Trace
Total	100%

Substitutions—10% of the above mixture can be replaced by dried ramie meal. Other grains and cake concentrates may be substituted in the ration.

Feeding — The Growing Chick

It is desirable to produce broilers weighing two pounds in from 6 to 8 weeks. This can be done by providing the growing chick with a high fat-protein ration plus all the water he can drink. A good ration to use follows:

Ground corn	30%
Rice bran	16%
Ground oats	10%
Fish meal	6%
Meat meal	6%
Coconut meal	10%

(*continued*)

Soybean meal	12%
Yeast residue (distillery)	7%
Mixed minerals	3%
Cod liver oil (1 pt per 100 lbs)	
Antibiotics	Trace
Total	100%

10% ramie meal can be substituted in the ration.

Feeding — Work Animals & Cattle

The nutritional requirements of cattle used as work animals have not been developed as have those for the various European strains of Bos tarus. For one thing the species Bos indicus (India cattle) and the water buffalo, Bos bubalis, make better use of their rations. The fact that these animals do not get concentrates at all does not mean that they should not. In fact it is well known that a 1000 lb Zebu ox actually requires 0.52 lbs of protein, 6.5 lbs of carbohydrate and 0.28 lbs of fat in his daily rations. Thus for a working animal of average size a daily minimum ration as follows is suggested:

50 pounds of green feed
2 pounds of oil cake

Add to this in the dry season in place of green feed, 10 lbs of silage or 25 lbs of good hay.

For fattening steers or bullocks use the following minimum daily ration:

50 pounds of green feed
3 pounds of cottonseed cake
½ pound of sesame cake

In all cases free choice of salt and water.

Feeding — Horses & Mules

The rule of thumb for feeding horses is 2 pounds of feed for every hundred pounds of weight. About 1/3 of the total feed should be in the form of concentrates. Mules are easier keepers than horses. An average size mule eats about 8 pounds of grain per day and 15 pounds of hay. If there is a serious intent to raise horses or mules, more exact information should be sought.

Local Material Useful For Feeding Mixtures

If a successful livestock industry is to be developed in Burma or in any tropical area, local sources of protein must be exploited. There are many tropical plants which produce such material and some have been put on trial. Among these are dehydrated Ramie, Desmodium, Pennisetum, Clandestinium, banana leaf, African palm meals and others. These plants are all grown locally and can be introduced in the rations mentioned in this chapter. These same materials have been used in rations for hogs, steers and baby chicks with good results and in fact have been found in some instances to be superior to alfalfa meal. An analysis of these materials appears in Part I Chapter 1.

PART II

LIVESTOCK IMPROVEMENT & PRODUCTION

CHAPTER 1

Beef Animals

To produce livestock acceptable on the world market has always been difficult in the tropics. Progress in this direction has been markedly less than in temperate zones and within recent years, as the result of efforts to upgrade livestock, breeds developed for temperate zones have been introduced to the tropics with indifferent success — even perhaps to the detriment of potential breeds already in existence. To most experts there is no rapid method for creating or improving breeds of livestock. Currently accepted breeds have taken decades and even centuries to perfect and the methodology is almost always that of careful selection and culling. In the case of the Asian tropics, the best authorities on the subject of animal breeding recommend selection and culling as the process to follow in livestock improvement, and not indiscriminate mixing of widely separated germ plasms. The only formula for success is to first determine what is needed, establish a standard of perfection and then select, breed and cull from stock available in the area until the desired standard has been reached.

Most tropical livestock producers are not concerned with beef production as such. Beef cattle are not grown and finished expressly for the retail meat market. This does not mean that it cannot nor should not. It does mean however that the trade

is not ready for a highly finished high quality carcass and therefore does not demand that it be produced as it is in Europe and North America. Even though the trade is not ready, it is high time that it be educated to seek and eat high quality beef. Burma, for example is capable of producing such beef, and the farmer, like the trade, needs to be taught its value and its production. Burma, like many other tropical countries, has thousands of acres of grazing land, a high potential for producing concentrates and above all, she has access to vast quantities of by products such as molasses, rice bran and oilcake, which could be used for finishing animals for the market.

Since it is not possible to point to any given breed and recommend it as the beef producing type for Burma, it can only be suggested that a few high meat yielding indigenous animals be selected and a beef breed be started from this selected group of animals. This may be done by an individual, by an association or by the Government. There is little doubt that a high quality beef animal can be produced, equivalent to or better than many of the European or American breeds, and all that is needed is for someone to make a start. There is one possible exception — it should be feasible to transplant direct some of the established beef crossbreeds such as Santa Gertrudis (Sindhi blood) and avoid the long breeding and selection process. The breed has been successfully grown in Latin America and is now established and recognized as a breed.

CHAPTER 2

Dairy Animals

In the field of dairy cattle production, the Asian Tropics has better than a good chance of producing a superior breed or strain in a very short period of time. Again this can be done with animals already in existence through the simple means of selection, breeding and culling.

To begin with there are the remnants of recognized dairy breeds and types long since brought into the country which through natural processes have become "native stock". Following are some of the basic strains which appear not only in Burma but have been seen in other parts of tropical Asia as well:

Bos tarus — European cattle
Holstein—Jersey—Brown Swiss—Gurnsey.

Bos indicus — Indian Cattle, Group III
Gir—Sindhi—Sahiwal—Deoni—Nimari—Dangii.

This latter classification of Indian cattle is one which has been proven to contain the best milk producers of the breed — color red, white, brown or combinations of all. Of this group the Red Sindhi is best known for milk production. Groups I, II, IV, V and VI are Indian cattle but they are more adapted to beef production or work. Group V, which includes a heterogenious mixture of Indian cattle, are small and vari-colored. Among this group are found unnamed strains which are potential milk producers.

The species *indicus* is found in Africa also and although they are used for milk, no strain has been developed which is known for milk production.

Bos bubalis — Water Buffalo

The water buffalo originated in Asia and from there was distributed to many parts of the world such as Egypt, India and Australia. These animals differ from the African buffalo (Bos caffer) which has not been domesticated.

The water buffalo needs shade, and water for submergence during the hot part of the day. This animal is the best known milk producer in the Tropics and may easily be classified as a tri-purpose animal, i.e. milk, meat and work. In India the strain Murrah is strictly a milk animal but the strains Kundhi, Nili, Ravi Surti, Jaffarbadi and Mehsana are dual purpose. In India the average milk production in dairy herds is about 4,000 pounds per year but individual animals may go as high as 8000 pounds. Butter fat is high, averaging 7% as against 4% for the ordinary milk cow. This, coupled with the average 1½ gallons per day yield of milk and a potential for 3 gallons, places this animal well on top of the list as a dairy animal for the tropics. Bos tarus may be a better dairy animal but not for the hot humid tropics. The one drawback to buffalo milk is that Asian people do not like the flavor and are not likely to try and accustom their taste to it. Even though it may be possible to keep strains of Bos tarus in the tropics, the animal has not demonstrated any of the ability of Bos indicus and Bos bubalis which enables them to withstand the heat, pests and diseases which are so fatal to cattle in tropical countries.

CHAPTER 3

Multi-purpose Animals

On this topic there could be written a large volume because in tropical areas cattle are used not for a single purpose but for multi-purposes. This term replaces that used in temperate zones—dual purpose—because the cattle are used for more than meat and milk as is implied by the term dual purpose. Multi-purpose cattle such as the India cattle or the water buffalo, must furnish meat and milk as well as traction and fertilizer which is no small portion of his service to man. In some areas of Africa furnishing fertilizer is often the only visible function that could be attributed to the animal. This is probably true as well in parts of India.

In most countries, it has not proven practicable to require so many services from one animal, and it is preferable to have an individual animal dedicated to just *one* purpose. One cannot com pound the various purposes in one animal without sacrificing quality in one or more of the other aspects. For example, in the United States, a top dairy cow will produce a minimum of 1,200 gallons of milk during one lactation in addition to her calf, and a beef cow will produce a calf which will weigh 1,000 lbs in 9 months, whereas a dual purpose cow will give about 600 gallons of milk and produce a calf which will weigh 600 lbs in 9 months. Thus the income from the combined specialised animals will amount to about 1,250 dollars per annum and the

income from two dual purpose animals would be about 1,200 dollars. A fifty dollar a year difference is sizeable.

Since in the tropics the demand is for multi-purpose cattle and will continue to be for many years, the most salient aspects of their production must be discussed.

As has already been pointed out, there are 3 species of the genus Bos under which the multi-purpose cattle fall. It will be useful to list these and some of the more prominent strains:

Bos tarus—Brown Swiss (M.(milk) Mt. (meat) and T. (Traction) Milking Short Horn (M, Mt. and T) Red Criollo of Spain and Costa Rica (M, Mt. and T) and The Criollo of Venezuela (M & Mt) Holstein (M & T).

At this point the temptation to recommend the Brown Swiss and Holstein for the tropics is great. These two breeds have been seen by the author in Panama, Ecuador, Peru and Venezuela where they were properly housed, fed and cared for and they give a good accounting of themselves. The fact is that tropical agriculturists do not expect to give a high quality animal any better treatment than they do the neglected native stock, so as a result the good animals die and earn for themselves the reputation of not being able to live or become adapted to the tropics. It might be said at this point that there is no substitute for "good care", if the farmer wants high production from his livestock. It is the author's belief despite tradition, hearsay and experience, that if a high producing herd of Holsteins or Brown Swiss are given the same care and treatment they

would receive in Holland or America, they would continue to live and produce at high levels. The animals should of course not be imported as adults but as calves (6 - 8 months). At high altitudes in the tropics where the climate is temperate Bos tarus has always performed well.

Normal treatment for dairy cattle in the temperate zone and that recommended for the Tropics is the same:

Baby calf management

1. Do not wean until colostrum ceases to flow.
2. Limited milk feeding for 7 weeks — Warm (100°F).
3. Free choice high protein hay and ground mixed grain after 3 days.
4. Scrub feeding pails thoroughly after *each* use.
5. Provide clear fresh water at all times.
6. Provide shelter and *dry*, *draft-free* pen 4' x 8'.
   (Larger calves 40 sq.ft. Provide clean, dry bedding daily.)

Large Heifers

1. Pasture, but have dry bedded shelter available.
2. Feed some grain up to 12 months of age and dry hay.
3. Breed at 14 months and continue with pasture and supplemental feeding to keep in top condition before calving.
4. Upon freshening feed in accordance with instructions under Part I, Chapter 6 on Nutrition.

Mature Cows

1. Pasture, dry hay and concentrates 12 months a year.
2. Abundant water, clear, clean and cool available at all times. Consumption averages 20 gallons per day.
3. Cows must be kept insect free at all times. This will require spraying the animal and the premises with DDT, Malthion, BHL or some other spray once weekly.
4. Cattle must be kept free of internal parasites. For useful remedies, when a veterinarian is not available, see Part I, Chapter 5 on Animal Pest Control.
5. Adequate housing—which includes the barn in which they are milked, the shed where they are bedded at night and the loafing shed where they seek shade and shelter during the heat of the day. The main requirements are that these barns be hard surfaced but *not* smooth, high and *dry*, and in the case of the night barn be supplied with *clean dry* bedding. (Change daily if necessary). Sawdust, rice hulls, cotton hulls and straw make good bedding material. The animal should never be uncomfortable, and muddy stagnant feed lots and pastures must be avoided.
6. Keep cattle in pasture when weather permits, otherwise cut green feed and supply cattle in loafing shed or other shelter.

CHAPTER 4

Poultry

There has been but little written on poultry production for the tropics and again the problem of producing for high egg production and quality meat production presents itself. As with cattle, the imported breeds do not become readily adapted to tropical conditions, but experience with improved breeds over the past 15 years has shown that with some trouble, egg and meat production can be had. The poultry generally seen in tropical countries are either the leggy stringy type which probably originated from the game cock, and the multi-colored or bare necked barnyard mixture which does furnish some meat but few eggs. These birds rustle their own food and as a result furnish the farmer about 30 eggs per year instead of the minimum 200. Even when fed a proper ration, the average chicken of this type produces but few more than 30 eggs although the meat may become of better quality. Hens and cockerels reach a live weight of 3 to 4 pounds (more often 3 than 4 pounds). Due to the fact that good breeds and pure bred birds can be and are raised in the tropics, the need for extensive research in the field of poultry improvement in the tropics has been eliminated. As has been stressed elsewhere in this hand book, there is no substitute for care and good management of livestock. No matter how good the breed, if feed, health, housing and sanitation are not up to standard your project will fail

Poultry Breeds

Any good breed including hybrids can be grown in the tropics; however the following breeds have been proven adaptable to tropical conditions:

Leghorns all colors	— egg production
Australorp	— ,, ,, and meat
Light Sussex	— ,, ,,
Rhode Island Red	— meat and eggs (can lay up to 170 eggs and weigh up to 8 lbs)
Barred Rock	— meat and eggs
Buff Orpington	— ,, ,, ,,
Hybrids	— meat—egg or dual purpose (sex linked cross between Light Sussex and Rhode Island Red can be made)

Care of Poultry

For the feeding of poultry (chickens) see Part I, Chapter 6. Again it should be emphasised that poultry must have access to *proper* feed and clean water (1 qt. per lb of feed) at all times if they are to prosper and perform their intended function.

As far as housing is concerned, poultry needs are simple. *Keep the birds dry and out of drafts.* Have plenty of ventilation and use large quantities (minimum of 6") of an absorbent litter. Change the litter (rice hulls, straw, etc.) when any sign of dampness occurs or once every 3 months. Laying hens require no less than 4 square feet of floor space per bird and growing chickens no less than 2—3 sq. ft per bird depending on size.

Chicken flocks must be watched constantly for disease. Any sign of disease or abnormality calls for immediate isolation and probable destruction of the bird. Weak or unthrifty chickens should be culled from the flock beginning with the first day after hatching. See Poultry Diseases—Part I, Chapter 5.

Other Poultry

1. Ducks—easily kept and managed—practically disease free. Require clean sanitary housing and copious water supply. Good foragers but need supplemental grain and pasture.
2. Geese—Same as for ducks but are poor breeders.
3. Turkeys—Not generally grown nor demanded in trade. Require dry climate, plenty of green feed, grain and pasture
4. Guinea Fowl—Well adapted to the tropics, especially in dry areas — are only semi-domesticated and require little care.
5. Pigeons—Easily grown and require little care, other than dovecots, supplemental grain and water.

CHAPTER 5

Swine

Hogs have traditionally been one of the major food sources in tropical countries, yet of all the animals, few have been more neglected. In some tropical areas the pig is actually the village scavenger, and a study of traditional customs will help to establish the antiquity of this animal in his association with man.

Types of swine found in the tropics vary considerably in conformation, color and purpose. In fact, they are probably of mixed origin and are most usually completely lacking in uniformity. The average type of hog native to the tropics is a miserable representative of the family *Suidae Sus* and like chickens this animal in its various breeds is so adaptable to tropical conditions that it does not pay one to improve the existing breed but rather to import improved stock. Again there is a big 'if' attached to this proposition; imported stock must be kept under clean sanitary conditions and must be well housed and fed if they are to live and prosper. Among the breeds widely and successfully used in the tropics are the English breeds known as Large White, Large Black, Middle White, Tomworth and Berkshire Other breeds such as Poland China and Duroc Jersey are used also.

Feeding Swine

The proper feeding of swine is described in Part I, Chapter 5. The correct rations are described but an adequate diet can be obtained by building around these standard rations with locally obtained feeds. For example, in Guatemala it has been demonstrated that high quality pork can be produced without the grain concentrate, i.e. by using the ramie plant as a source of protein either as pasture, green cut feed or as a meal concentrate. Ramie tissue contains about 21% protein. A ration consisting of root crops chopped and mixed with meal made from dehydrated ramie, desmodium or banana leaves, and including a small quantity of ground grain plus mineral mixture making up 2 to 3% of the total ration, should be available in almost any tropical areas. An even cheaper way of producing pork is to furnish the swine with all the high protein pasture that they will eat. Ramie pasture is highly recommended. Only a small amount of grain is needed under this system. *Do not feed garbage unless it has been boiled or sterilized.*

Housing Swine

Because the pig has no sweat glands, artificial methods must be used for keeping the animal cool. This usually consists of shade and moisture, but not a bath of stinking sour mud. A rough finish concrete floor is recommended. In one corner there should be a depression kept full of water or moist sawdust. Ventilation must be complete but avoid drafts. A clean fresh supply of drinking water must be on hand at all times. Each farrowing sow should have 150 sq.ft of floor space with plenty of clean

litter. *Keep the pig pen dry and clean* to avoid outbreaks of disease.

Raising Young Pigs

Wean the young pigs at eight weeks of age, putting them on a diet similar to that described in Part I Chapter 6. Castrate unwanted boars at six weeks and isolate the uncastrated males from the rest. Young pigs should have at least 25 sq.ft per pig (combined sleeping and feeding space).

CHAPTER 6

Miscellaneous Animals

There are a great number of animals produced in the tropics which although of no great importance should be mentioned for their potential if nothing more.

Goats — Truly a poor man's animal and certainly the most destructive to native vegetation when not properly confined and cared for. A cheap source of milk and meat and wool — essentially a browse animal and found worldwide where browse is available. Tropical goats need upgrading and can be valuable family type animals if properly cared for.

Sheep — Sheep are relatively unimportant in the tropics except in cool areas and high altitudes — excellent for meat, milk and wool but require more care than goats. Sheep are very susceptible to disease and in the wet tropics are very susceptible to foot rot. Animals browse as well as graze; but must be kept as dry and cool as possible, hence stall feeding is often practised during wet periods.

Horses — A delicate animal very susceptible to disease and requiring constant attention. In the Tropics the horse is generally used only for riding and even this must be moderate.

Mules — Less delicate than the horse and used as pack and draft animals.

Donkeys — Popular as pack and draft animals throughout the tropics — disease resistant and easy keepers.

Llamas — Highland areas of the tropics — pack animals but useful for meat and wool.

Elephants — Heavy hauling and timber roustabouts — slowly being replaced by machinery—low tropics.

Ostrich — Feather production only.

Rabbits — Excellent for supplemental home meat supply — do well in tropics — keep dry and provide with grain, vegetables and water.

Guinea Pig — Domesticated cavy. Easily cared for and thrive under tropical conditions — keep animals dry and supplied with vegetation, grain and water. Nature will take care of the rest. Excellent for supplemental home meat supply.

PART III

FIELD CROP PRODUCTION

CHAPTER 1

Cut-Forage And Pasture Plants

Improvement of forage and pasture grasses in the tropics has been slow and there has been a general reluctance to introduce new species when the old "standbys" were still serving the purpose. Recent advances in animal nutrition and in the chemical make-up of plants has shown that many of the old "standbys" leave much to be desired in the way of nutrition. In fact, it has been often observed that animals can suffer from malnutrition while grazing in pasture with luxuriant growth.

Pasture grasses in the tropics fall in 2 classes (1) those to be cut and fed to the animal direct (green or dried) and (2) those which are used for grazing. Actually the second group may be cut also but because they are readily consumed by the animals they are usually directly grazed by the animals. One of the biggest drawbacks to forage production in the tropics has been the lack of leguminous plants, and up until recently there were no high protein non-legumes which could be substituted. Even now some leguminous plants have been discovered which do well under tropical conditions and which grow well in mixtures of grasses. Following are a few major forage plants which are well adapted to tropical conditions and should be considered in any mixed pasture program:

Legumes For Short Pasture Mixtures

Centrosema Plumieri — Centrosema

Centrosema Pubescens— Centrosema

Desmodium heterophyllum & canum—Spanish clover — mixed pasture

Hedysarum coronarium

Indigofera subulata— Widely used in legume pasture but reported in some areas as toxic.

Mikania scandens

Parochetus communis

Grasses For Short Pasture

Astrelba pectinata— Mitchil grass (Africa)

Axonopus compressus — carpet grass

Bromus marginatus— Tropical bromegrass

Chloris gayana— Rhode grass

Digitaria decumbens— Pangola grass

Eragrostis tenella & spp. — Love grass (Ceylon)

Panicum compositus

Panicum longiflorum— creeping grass

Panicum prostratum— creeping grass

Paspalum scrobiculatum (*rotatum & conjugatum*)

Pennisetum clandestinum— Kikuyu grass

Non-Legume Plants For Short Pasture

Boehmeria nivea— Ramie (fiber plant) but high in protein and palatable

Justicia procumbens — Prostrate spreading herb.

The grasses, legumes and herbaceous non-legumes are a few of the many plants suggested for short pasture grass. Seldom if ever are these plants seen in mixtures but there is little or no reason why they should not be. A good pasture must include a legume or a high protein non-legume if it is to furnish proper nourishment for livestock. If it does not seem practical to grow these plants together, they should be grown in rows or blocks in the same field so that the animal has immediate access to his needs through free choice.

The subject of pasture grasses is large and for the purposes of this handbook only a few of the more important ones are listed. The listing is not in accord with any pre-conceived design or purpose. See tabular summary Part I Chapter 1.

Useful Pasture Grasses For Humid Tropical Areas

Acroceras macrum — palatable — wet countries.

Agrostis spp. — dry zones — poor pasture, but better than nothing.

Andropogon spp. — generally coarse and unpalatable — the genera *Imperata saccharum* (sugar cane) is probably the only useful species.

Axonopus compressus — savana grass — fair pasture.

Brachiaria decumbens — excellent in mixed pasture — is weak in pure stand.

Brachiaria brizantha — excellent pasture grass.

Brachiaria soluta — excellent pasture grass.

Brachiaria mutica—(*Panicum purpurescens*) para grass —excellent pasture and best known.

Chloris Gayana—Rhodes grass—short lived perennial—excellent pasture.

Cynodon dactylon—Bermuda grass—very palatable, short grass—other valuable species.

Dicanthium caricosum—blue grass of Nadi—good pasture and quite palatable.

Digitaria decumbens—Pangola grass—excellent high protein (20%) grass—recently used.

Echinochloa Pyramidalis—dry areas, palatable.

Echinochloa stagnina—one of the very best for pastures.

Eleusine coracana—Dry sandy areas—excellent grain.

Eremochloa ophiuroides—centipede grass—native of Asia—best in meadow land; forms thick sod—only fair pasture but excellent for erosion control.

Eriochloa spp.—good pasture.

Eragrostis superba—dry sandy areas—Medium palatability.

Hyparrhenia spp.—From Africa and considered very good in South America.

Ischaemum aristatum—Dense pasture and excellent forage—may color milk in certain stages (native of Asia).

Ischaemum timorense—Excellent pasture in high rainfall areas (native of Asia)

Ixophorus unisetus—Excellent forage.

Milinis minutiflora— Molasses grass—sweet smelling—repels insects—excellent pasture.

Panicum spp.— Most widely grown grass in the tropics—excellent pasture. Some of the better species follow.

Panicum aritum— Very palatable.

Panicum maximum— Not easy to propagate—good pasture grass.

Panicum repens— Not too good—wet areas.

Panicum trichocladum— Wet areas—good pasture grass.

Panicum coloratum— Good for wet-dry areas.

Paspalum dilatatum— Dallas grass—excellent pasture.

Paspalum notatum— Bahia grass—not too palatable but forms good sod.

Pennisetum purpureum— Elephant grass or napier grass—one of the best—does not withstand heavy grazing.

Pennisetum clandestinum— Kikuyu grass—non seed producer—excellent at all altitudes.

Pennisetum orientale—Excellent—native of India.

Polystrias praemosa— native of South-east Asia.

Rottboellia exaltata— Palatable, succulent and spreads rapidly.

Sorghum halepense—good forage but hard to eradicate (Johnson grass)

Sorghum sudanense— Sudan grass—excellent hay crop.

Sorghum verticifollium— good hay crop.

Themada triandria— excellent pasture because of its palatability—low food value—native to Asia.

Tripsacum laxum — Guatemala grass — vigorous grower and highly palatable, more persistent than elephant grass—cut forage — does not produce seeds but easily propagated by cuttings.

Useful Legumes For Cut-Forage

Cajanus Cajan—Pigeon pea — excellent cut-forage crop—perennial—palatable.

Centrosema pubescens—Valuable fodder crop.

Dolichos lablab—Lablab bean—produces dense mass of fodder.

Glycine soja — soybean — exceptionally high in protein and palatable.

Indigofera endecaphylla—Excellent feed—reportedly toxic certain stages.

Leucaena glausa — Ipil Ipil — poor man's alfalfa — bush 10 to 30 ft high — branches make excellent feed.

Mimosa pudica—Sensitive plant—used for sheep and goats, not for cattle.

Pueraria phasioloides & hirsuta—Kudzu—excellent cut feed.

Stylosanthes guianensis—Townsville clover—erect—24 to 48 inches—dry areas.

Vigna catjang—Cow-pea—excellent forage.

CHAPTER 2

Leguminous Crops

Whether leguminous crops are always beneficial when used as green manure soil improvers in the tropics is debatable but their value as high protein food for both man and beast is an established fact. Thus in the tropics where protein in the diet is especially needed, the value of the crop cannot be underestimated. Most of the commonly known legumes such as beans and peas, are high in fats as well as proteins, e.g. the black bean has 24% protein and 2% fat and the pigeon-pea has 22% protein and 2% fat. These two plants will grow in anybody's backyard and a few plants will furnish protein the year round for a single family. Some of the beans and peas of course are high in both protein and fat, e.g. the soy bean has 40% protein and 20% fat and the groundnut pea runs 20% protein and 40% fat. The most important members of this family and their culture in tropical areas follow:

Beans

Canavalia ensiformis — Sword bean — woody perennial climber or bush — sow in rows 2½ ft x 2½ ft — 25 lbs per acre — large white beans.

Cyamopsis psoralioides — Bushy perennial — sow in rows 2½ ft x 2½ ft — edible bean or pod.

Dolichos lablab — Hyacinth bean — vigorous annual grower — seed rate 30 lbs per acre — yields 400 lbs per acre — a similar species is the well known horse gram — rows 2½ ft x 2½ ft.

Lathyrus sativus — Vetchling bean — a perennial pea.

Phaseolus vulgaris — Common kidney bean — pods edible — dwarf var. common to the tropics — seed 40 lbs per acre — plants spread 1 ft x 1 ft — matures 3 to 5 months — average yield 700 lbs per acre — seed rate 40 lbs per acre.

Phaseolus acutifolius — Tepary bean — small white — matures in 2 months — low rainfall — useful as catch crop — seed rate 10-15 lbs per acre — yield is 500 lbs per acre.

Phaseolus lunatus — Lima bean or butter bean — large white seed — seed rate 45 to 75 lbs per acre — yield 1,500 lbs per acre — bear over period of several months — sow 1 x 4 ft apart.

Phaseolus angularis — Adkuzi

Phaseolus mungo — Black gram bean — small annual bean — withstands drouth — sow 15 lbs per acre — yield 500 lbs per acre.

Phaseolus trinervius — Jerusalem pea.

Psophocarpus spp. — Goa bean — Edible pods and tuberous roots — sow in drills 4 ft apart or on fences — yield 2 tons per acre.

Pachyrhizus tuberosus — Yam bean — edible tubers — strong, climbing bean — drill in rows 4 ft apart with beans 15 inches in the row.

Vigna sinensis — Cow pea — dry climate to wet — seed rate 15 to 20 lbs per acre — plants 2 x 3 ft apart — yield 400 lbs per acre.

Vigna sesquipedalis — Yard long bean — twining annual bearing long pods 3 ft. long. Sow 1½ x 4 ft apart.

Peas

Arachis hypogaea — Groundnuts (See Oil-producing Field Crops)

Cajanus Cajan — Pigeon pea — perennial shrub 6 ft. — seeding rate 10 lbs per acre — 2 seeds per hill 4 x 5 ft apart —fruiting 4 to 6 months — prune to 1 ft for second season — yield 600 lbs per acre — excellent fodder and good coffee shade — pea is delicious as a food — yard plant.

Cicer arietinum — Chick pea, garbanzo — seed rate 40 lbs per acre — plants 2 x 2 ft — yield 400 lbs per acre 4 months to maturity. Drouth resistant.

Glycine soja — soybean (See Oil-producing Field Crops)

Lens esculenta — Lentils — cool zone — seed rate 40 to 80 lbs per acre — 3 months to maturity — yields 500 lbs.

Pisum sativum — Field pea — grows best in cool zones — seed rate 70 lbs per acre broadcast — 4 months to maturity — yield 600 lbs per acre.

CHAPTER 3

Cereal Crops

Next to legumes, the most important crop is the cereal, not because of its high nutritional value but because, since time beyond memory, cereals have been grown and depended upon by man for the major portion of his food supply. Even today rice makes up the major portion of the Middle and Far Eastern diet.

Following is a list of the more-important cereal crops and their culture in tropical areas:

Oryza sativa — Rice-Paddy — 2 types, swamp or aquatic rice anc. upland rice. Swamp rice is perhaps the greatest water user of all known crops, requiring almost 6 feet of water during the 4½ month growing period. Rice is classified as to hardness of grain — vitreous and soft grains as well as on rate of maturity and grain color. Rice is also very sensitive to length of day. Upland and aquatic rice varieties are not interchangeable, i e. aquatic varieties should not be grown as upland rice. In general, there are two main groupings: (1) *japonica* which is more sub-tropical, high-yielding with round grains and (2) *indica* which is best adapted to tropical conditions — long grains and medium yield.

Upland rice grows up to altitudes of 6,000 ft — requires heavy rainfall — broadcast or drill may require up to 70 lbs per acre to get a good stand, however 25 lbs should be sufficient — cultivate and

weed as with other cereal crops (upland rice has a higher nutritive value than aquatic rice).

Aquatic rice — sow up to 70 lbs of seed in flooded rice nursery of 1/30 of an acre — this produces enough plants to sow 1 acre — when seedlings are 8 inches high transplant to puddled, flooded, field 6 to 12 inches apart and 2 to 4 plants to each hole. (If desired broadcast 100 lbs of rice seed per acre on wet puddled field and flood.) Keep fields flooded until grain is yellow and ready for harvest — five months from seeding to maturity — yield averages 1,500 lbs per acre but may go as high as 6,000 pounds on well - fertilized field.

Zea Mays — Corn — probably the world's most widely cultivated crop — grown within and without the tropics — grain color is either yellow or white but may be any color or varigated. Yellow corn is the most nutritive — two main types, flint or dent corn and starch corn — either type is edible and furnishes best concentrate for livestock — high yields up to 150 bushels per acre is possible with hybridization — normal yield would be 20 to 40 bushels per acre (1 bushel = 60 lbs). Culture — for hand cultivation sow seed 3 x 1 ft, using 3 seed to the hole and using 8 lbs per acre. (Up to 20 lbs may be needed for machine sowing) — sowing to harvest requires from 90 to 150 days — usual weeding and cultivation necessary — if hybrid corn is used it *must be purchased fresh each year.* DO NOT USE SEED PRODUCED FROM HYBRID SEED CORN *for next year's crop.*

Sorghum sativa — Milo or Kaffir is a popular resistant crop which produces excellent grain and fodder for livestock, and grain for human consumption as

well. The nutritive value is equal to corn. Seeding rate is 10 lbs per acre when grown for grain and 100 lbs when grown for fodder. A crop is produced in from 90 to 120 days and yields 1,500 lbs per acre. Members of this genus furnish straw for brooms, sweet syrup and grain.

Sorghum sudanense — Sudan grass — a valuable pasture grass as well as grain producer.

Sorghum halepense — Johnson grass — a notorious weed in the United States but an excellent fodder. Grain is not usually harvested separate but can be. Culture for both Sudan and Johnson is the same. Seeding rate is 15 lbs per acre for seed production and 100 lbs per acre for forage or pasture. Yield of grain may go as high as 2,000 lbs per acre — crop matures in 180 days — fodder yield may reach 20,000 lbs green weight per acre. The sorghums have a tendency to bloat livestock and should not be fed when frosted, or killed by extreme drouth.

There are a great many other plants grown for their grain which should be mentioned; some of these are:

Amaranthus spp.

Chenopodium Quinoa

Coix Lachryma — jobi — Job's tears — large seeds — cultivated in eastern tropics same as for sorghum — cereal or fodder.

Digitaria exilis — Hungary millet or rice — matures 3 to 4 months — culture same as sorghum — drouth resistant.

Echinochloa frumentacea — Japanese millet — 5 to 8 lbs per acre broadcast.

Echinochloa colona — Same as for Japanese millet.

Eleusine coracana — Finger millet — 6 to 8 lbs per acre — matures 4 to 5 months — yield 1,200 lbs per acre — human as well as animal consumption.

Eragrostis abyssinica

Fagopyrum esculentum — Alforon.

Panicum Crus-galli

Panicum miliare — Little millet (Proso)

Panicum miliaceum — Common millet

Pennisetum typhoides — Pearl millet and species *specatum* — bulrush millet and many others — broadcast 3 to 10 lbs per acre — yield 500 to 1,000 lbs of grain per acre.

Paspalum scrobiculatum

Setaria italica — Italian millet

Temperate cereals such as wheat, oats, barley and rye are grown only in the cool tropics usually 5,000 feet and above — yields are usually low (500 — 1,000 lbs per acre). In general sow these crops broadcast 50 to 70 lbs per acre (oats 25 lbs) — crops mature in four months or less and should yield no less than 500 lbs per acre.

CHAPTER 4

Fiber Crops

No crop other than food is more essential to mankind than fibers. In fact the two words, food and clothing, (food and fiber) have been used so long as representing the main essentials of man's needs that they are thought of as a single word or need. Vegetable fibers are usually classed as:

Soft fibers—cotton

Long soft fibers—Jute, flax

Long hard fibers—Sisal; musa

Of all the fibers, cotton is the most widely grown and used. The other fibers are mostly limited to industrial uses and with the exception of flax are best grown in tropical and sub-tropical areas. A discussion of individual fiber crops follows:

Gossypium spp.—Cotton—The southern part of the United States of America produces the major part of the world's cotton supply. Cotton can be grown in the wet tropics but it has been more successfully grown in the arid portions of the tropics under irrigation or in the last half of the wet and the first half of the dry seasons in the wet tropics.

The major commercial difference in cottons is fiber length:

American middling—1 in.

Sea Island (West Indies)	—1 5/8 in.	—2¼ in.
Egyptian	—1.3 to 1.5 in.	
African & Indian	—less than 1 in.	

Culture—space 3 ft x 1 ft—4 to 5 seeds per hole, 3/4 in. deep (10 lbs seed per acre). Thin to 2 stalks when 6 in. tall—keep fields free from weeds throughout growing season—first picking 4 months from germination (approx)—finish harvesting in 2 more pickings—one picker can pick 75 lbs per day and a good yield is 500 lbs of lint per acre for rain produced cotton—cotton is subject to many insect pests and frequent spraying with DDT, Malthion or equivalent is necessary.

Hibiscus cannabinus— Kenaf — Annual malvaceae, high in lignified fiber—hermaphroditic—plants 6 to 12 feet tall—stem green or red, slender and non-branching—leaves simple and compound—originated in Africa—grows in wild state in Asia and Tropical America—low altitude, uniform temperature, min. 16°C—rainfall minimum 5" monthly during growing season—soils not exacting moderate level fertility. Fertilizer on poor soils improves yields, 40 pounds N, 70 pounds P_2O_5, 50 pounds K_2O—seeding rate 22 pounds per acre, —rows 30" apart, plants 10 inches in the row for fiber—harvest by hand or by modified combine—yield of fiber 3 to 5 percent of green weight—date of harvest 90 to 155 days. Fiber yield should be between 1,000 and 2,000 lbs. Seed is harvested when lower pods shatter—fiber is extracted from green plant by machine (decorticator) or by retting in water. (Fermenting process requires 1 to 3 weeks)—stem

borer kills terminal bud—leaf beetles, weevils and caterpillars cause leaf damage—insecticides DDT, BHC or chlorodane. Fungus diseases such as tip blight, rootrot, etc. do occur but to date no recommended treatment, other than standard fungicides. Kenaf planting is highly recommended for the tropics in both the dry zones (irrigation) and the southern tropical zone (natural rainfall). Kenaf is light, sensitive and in N. Latitude should be sown in May for fiber and in September for seed. Other species in this genera useful for fiber production are *Hibiscus sabdariffa* (Roselle), *Hibiscus tunariifolius* and *Hibiscus tiliaceus*. Culture for these are the same as for Kenaf.

Corchorus spp.— Jute – Second most important fiber crop—industrial uses are sacks, bags, burlaps, etc. —2 major species *capsularis* which withstands flooding and *olitorius* which is an upland type of lesser quality. In the N. latitude sow seed (15 lbs per acre) in February to June—thin plants to 6 in. in the row with rows 30" apart—for seed production leave plants 15 inches apart in the row—harvest in from 3 to 4 months while plant is half in flower and half in fruit—stems will be 10 to 12 ft at harvest (or less in poor soil). Harvest stems in bundles and ret in water for 10 to 30 days; some prefer to remove cortex from stem before retting. After retting take what remains of fiberous cortex, wash until only clean fibers remain, dry and bale. Yield 1,300 lbs per acre.

Boehmeria nivea — Ramie — China grass — cultivation extends to cooler zones — propagate by root divisions spaced 1 ft x 1 ft. Perennial requiring a rich soil — fiber is one of the finest but because of difficulty of extraction is not widely used. May

be harvested and processed like jute or extract fiber with mechanical decorticator. Fiber yield should be 1,500 lbs per acre with 3 cuttings per annum. Plant is also useful as a high protein fodder. Replant stand every 5 to 7 years.

Crotolaria juncea — Sunn hemp — a typical long soft fiber — sow 50 lbs per acre — broadcast and thin to 3 or 4 inches — crop matures in 3 to 4 months — stem 6 ft — harvest or ret similar to jute — yield 500 lbs per acre dry fiber.

Linum usitatissimum — Flax — best for tropical high lands — cool climate — sow seed 25 lbs per acre — crop matures in 3 months — yield 400 lbs per acre dry fiber — valuable as an oil crop — decortication by machine.

Other important long soft fibers include:

Phormium tenax — New Zealand flax

Urena lobata

Abroma agusta

Of the long hard fibers, there are several which are of great commercial importance:

Musa textilis — Manila hemp — abaca — a near relation of the banana — suckers are planted 10 ft x 10 ft — yield fiber laden stems in 2 years — plantation good for 15 years — to harvest cut stems just before flowering — fiber is extracted by machine decortication — yield is 2 tons of dry fiber per acre.

Agave sisalana — Sisal — most important of several related species.

Agave fourcroides — Henequen hemp

Agave cantula — Maguey

Agave heteracantha — Istle fiber.

This group of hard fiber plants are of great importance because they can be grown in a hot dry climate and in calcareous soils. Suckers or bulbils sprouted and 6 mo. or more of age are transplanted at the rate of 1,500 to 2,000 per acre (8' x 6') — harvest of leaves begins when plants are 3 years old and the life of the plant is from 5 to 10 years — leaves are mechanically decorticated, then fibers are washed and brushed. Fibers are used largely for binder twine as well as cordage — plant produces from one pole 15 — 200 bulbils — does not produce seed.

There are many other genera which produce fiber and although many of these are of little or no commercial importance, they are listed here as potential fiber crops:

Abroma augusta — Stem fiber — requires retting, used for rope.

Abutilon Avicennae — Chinese jute — a mallow grown in China.

Ananas Magdalenae — Wild pineapple — propagate by suckers — good fiber yielders — some species so fine it is used for cloth — many species used for fiber.

Asclepias currassavica — perennial shrub — fine fibre for textiles — West Indies.

Bromelia Pinguin — Wild pineapple — hedge plant — leaves 6' — pinguin fiber is excellent.

Cannabis sativa — Indian hemp — nettle family — produces fiber and drug known as hashish and marijuana.

Cyperus Papyrus — Excellent for paper making.

Cyperus corymbosus — Sedge 4 to 5 ft, used for matting.

Luffa aegyptiaca — Gourd — fruit is retted to obtain scouring pads.

Pandanus utilis — Screw pine for weaving huts, mats, etc.

Pueraria thunbergiana — Kudzu — useful fiber as well as forage.

Sansevieria spp. — Bowstring hemp — silky white tough fiber — grows well in dry or moist climate — culture and processing similar to agave — plant 2 ft x 1 ft from suckers.

Besides the usual herbaceous fiber producers, many palms and trees produce useful fibers worthy of mention :

Allaeanthus Zeylanicus — Alandu.

Adansonia digitata — Baobab tree.

Arenga saccharifera — Bristle for brushes.

Bauhinia racemosa — Majila.

Borassus flabellifer — Palmyra fiber.

Calotropis gigantea — Mada fiber.

Caryota urens — Kitul fiber — an excellent yielder.

Ceiba pentandra — Kapok — stuffing.

Cocos nucifera — Coir — Coconut fiber.

Phoenix zeylanica — Matting.

Another fiber which should be mentioned although it is not a vegetable fiber is silk. This long continuous fiber is formed from the caterpillar of several species of moths :

Anthera paphia — feeds on a wide variety of plants, e.g. *Cassia, Eugenia, Terminalis*, etc.

Attacus ricini — feeds on castor leaves.

Bombyx mori — feeds on mulberry leaves.

Morus alba — feeds on mulberry leaves.

The moth lays her eggs on a leaf or twig and these are hatched out in trays. Upon hatching the young worms must be fed their needed leaf diet. Spinning begins in 2 to 4 weeks. When cocoon is finished, worm is killed by heat and the thread unwound and spun.

CHAPTER 5

Root Crops

Root crops of the Tropics have been taken for granted for so long that they are in the same category as the Irish potato of the temperate zone, i.e. so common that they are not usually discussed. Yet the importance of the root crop, regardless of the zone is so great that almost every meal is graced with some form of the lowly root throughout the world.

The tropical root crops are many, though few are known beyond the tropical world. A few of the more important are here described, with the hope that there may come about a greater interchange of species among the various tropical zones.

Amorphophallus campanulatus— Large herb—bears a corm instead of a tuber—2 ft high—corm may weigh up to several pounds—native to tropical Asia—humid tropics—usually harvested in wild state although cultivated to some extent on small farms and gardens—eaten as a boiled vegetable and highly esteemed.

Calathea Allouya— Perennial herb about 2 ft high—fiberous tubers resemble potatoes—Tropical America—West Indies—humid tropics—propagate by tubers or suckers —boil —must acquire taste — hard and gritty.

Canna edulis— Purple arrowroot—perennial herb 3 ft to 5 ft high—tuberous rhizomes 8 to 10 per

plant—native to West Indies—tropical—plant rhizomes 3 x 2 ft—6 to 8 months to mature—yield 5 to 8 tons per acre—processed as starchy flour or boiled as vegetable.

Colocasia antiquorum — Dasheen — Taro — Herbaceous tuberous perennial — tubers size of small potato with fiberous skin — botanically not a tuber but a corm — tropical — low lying moist ground — plant corms 3 x 3 ft — yield 3 to 5 tons per acre — mature in 3 to 5 months depending on variety — some variety leaves are cooked — corms boiled.

Coleus spp. — Kaffir potato — rhizomatous plant — not well known outside of tropical Africa—plant rhizome — 5 months to maturity — very low yield — boiled vegetable.

Curcuma angustifolia — Robust perennial herb with tuberous roots — yellow tuber serves as yellow dye and used in curry — native to Asia — propagated from tuber divisions.

Dioscorea spp. — Yams — Fourteen or more important species — herbaceous twiners — large underground tubers — African origin — tropical — deep loamy soil — plant 4 x 3 ft apart — use sets taken from crown with 2 or 3 eyes — cooked like potato.

Ipomoea Batatas — Sweet potato — trailing perennial bearing tubers — native to both hemispheres — requires dry climate or in any event not excessive rain — plant slips grown from tubers — light textured soil — plant 1 x 2 ft — mature 4 to 5 months — yield 4 to 5 tons per acre.

Manihot utillissima — Cassava — Tapioca — Yuca — shrubby perennial 6 ft. tall — native to Tropical America — tropical — propagate by stem cuttings

10" x 12" — plant 4 x 3 ft — 10 to 12 months to mature — yield 6 to 8 tons per acre — eaten as a potato or used to extract starch.

Maranta arundinacea — Arrowroot — rhizomatous plant — native to tropical America — plant tubers or suckers 2 x 2½ ft — 6 inches deep — yield 4 to 6 tons per acre — eaten as boiled vegetable or grated and washed for starch.

Oxalis crenata — Small Peruvian herb grown for marble sized tubers — eaten as boiled vegetable.

Plectranthus tuberosus — Coleus potato — small herbaceous plant — bears small insipid tasting tubers — Java.

Solanum Tuberosum — Potato—best grown at higher altitudes — grown year round but not within 15° of the equator — plant 2½ oz tuber or cut tuber 12 in. x 24 in. apart — sow 800 lbs to 1 acre — yield 10,000 lbs per acre.

Tacca pinnatifida — Indian arrowroot — stemless perennial — tuberous herb of Ceylon — prefers dry climate — plant divided tubers 2½ x 1 ft — used for starch flour and eaten as boiled vegetable.

Xanthosoma sagittgaefolium — Tannia — similar to colocasia — grown on drier ground — propagation etc. same as for colocasia.

CHAPTER 6

Sugar Crops

Sugarcane is a crop which has a worldwide requirement. It is widely grown from the tropics to the sub-tropics and furnishes at least half of the sugar consumed in the world. The other half is a product of the sugar beet, a temperate zone plant and is of no use to this handbook. Besides the sugarcane, there are other sugar-producing plants but they are of no commercial importance. Some are mentioned here because of the importance to local communities throughout the tropics.

Saccharum officinarum — Sugarcane — worldwide useage — a grass reaching 8 to 12 ft — high in sugar content — originated in Asia — tropical — requires heavy fertilization and lime — hot humid climate — propagated vegetatively — stem cuttings of 2 to 3 nodes set 5 x 5 ft in plowed 12" deep furrow and covered with plow. Harvest in 12 to 18 months — new crop comes after harvest from suckers — because yield falls off, new plantings should be renewed every 2 to 4 years. Some growers renew planting each year — yield 30 tons per acre or 3 tons of sugar — from the juice is extracted sugar and alcohol.

Sugar Palms — a large genera of palms is useful for the production of sugar. Besides the usual date

and coconut palms, sugar is produced from :

Arenga sacchariferа— Malay sugar palm

Borassus flabellifer— Palmyra palm

Corypha elata—Buri palm

Caryota urens—Kitul or Toddy palm

Many of these palms will produce as much as 25 pounds of sugar per tree and in India as much as 50,000 acres are devoted to this product.

Besides the sugar, the sap from these trees produce a toddy which is highly esteemed in the tropics. Three other less important sugar producers are:

Elaeis spp.— Oil palm whose sap contains a high sugar content.

Nipa fruticans—Nipa palm—high yielder of sugar—a creeping aquatic palm.

Raphia vinifera—Wine palm.

CHAPTER 7

Oil-Producing Field Crops

Edible oils produced from field crops have become increasingly important in the last decade. In fact the use of vegetable oils has almost eliminated animal fats except for butter on the market. In this chapter only the more important of the fixed oil crops are described and mention is given only to the less imporant.

Arachis hypogaea — Peanut —small annual trailing legume—native to Brazil—tropical to sub-tropical—sandy soil—propagate from seed — sow in rows two feet apart, plants 9 inches apart in the row—mature in 5 months—yield 1,500 lbs per acre—later roasted or most widely used for extraction of cooking oil.

Carthamus tinctorius — Safflower — originated in India — a small thistle-like shrub 2 ft to 4 ft high — aster-like flowers are used as dye and seeds have a high oil content. Sow 18 inches x 22 inches at the rate of 6 lbs per acre — requires light soil — flower yield 80 lbs per acre — yield of seed per acre 1,500 lbs.

Gossypium spp. — Cotton seed (See fiber crops).

Guizotia abyssinica — a plant similar to sesame. Seed rate 8 lbs per acre and yield is 400 lbs per acre —a good substitute for linseed oil.

Glycine hispida — soy bean — erect annual 2 to 4 ft — native to China —prefers sub-tropical climate —

sow in rows 1 x 2 ft — matures in 3 to 4 months — sow 20 lbs per acre — yield 1,000 lbs seeds per acre — high oil yielder and one of most important field oil crops.

Helianthus annus — Sunflower — tropical to sub-tropical — broadcast seed 10 lbs per acre or sow in rows 3 ft apart, 1 ft apart in the row — matures in 4 months — yield 1,000 lbs of seed per acre.

Sesamum indicum — Sesame — an erect annual 2 ft to 4 ft, native to Ceylon — tropical to sub-tropical — sow broadcast 10 lbs per acre or drill in rows 1½ ft apart — matures in 4 months — yield 600 lbs per acre.

Other Species

Brassica juncea — Mustard.

Cannabis sativa — Indian hemp.

Papaver somniferum — Poppyseed.

CHAPTER 8

Miscellaneous But Important Field Crops

Capsicum spp. — Chillies — small herbaceous plants producing fruiting pods from 1 inch fingerlings to 6 inch diameter fruits — range from sweet to extremely pungent — 1 lb of seed plants an acre— transplant after 45 days setting 1½ ft x 1½ ft — crop period is 4 to 7 months — yield is 2,000 lbs of fresh pods or 800 lbs dry — powder from ground chillie is used in hot sauce throughout tropical areas.

Nicotiana spp. — Tobacco — This plant thrives from the equator to temperate latitudes. It requires a light soil and is transplanted from seed—seed are extremely small — sow seed in nursery — 1 teaspoonful to 20 sq. yards — transplant to field in 8 weeks — matures 3 months from transplant — set plants 3 x 3 ft — top plant at flowering and remove all suckers as they form in the leaf axils — harvest in 4 to 5 pickings when yellow splotches appear on leaves — yield 500 lbs of leaves per acre.

PART IV

VEGETABLE CROP PRODUCTION

CHAPTER I

Basic Information

Most of the vegetables that are commonly known in temperate zones can be grown in the tropics. This is not too surprising since many of the vegetable plants grown in the temperate zones actually had the tropical zone as their origin and, in fact, are found growing wild in many tropical countries. Because of the intensive breeding and selection programs carried on in the temperate zone many of the vegetables have become adapted to that zone and as a result are no longer well adapted to their native state. Thus it becomes important to avoid vegetable crops which are not proven even though they may be of tropical origin

Among the well-known vegetable crops which originated in the tropics are: Tomato, sweet potato, lima bean, potato, cow pea, egg-plant, chayote, corn and possibly the common bean, soy bean, okra and melon. Naturally the growing of these plants like any others depends on variety, soil type, fertility, altitude and rainfall, but with common sense as a guide most vegetables can be produced in abundance As has been pointed out, most areas in the tropics have their high zones, their dry zones and their low hot zones. Countries such as Burma, blessed with this climatological variation, plus transportation facilities, have no problem and the people can be supplied with temperate zone vegetables such as celery, peas and lettuce with little difficulty.

In general in the tropics vegetables can be placed in two convenient zones:

1. Cool zone or winter-crop

2. Hot zone or summer-crop.

In the cool zone will be found vegetables which do well in temperatures varying between 50 and 70 degrees F. and which will not tolerate temperatures of more than 75 degrees Fahrenheit. Neither will they be adaptable to high rainfall or soggy, water-logged soils. Those vegetables adapted to the hot zone grow best in relatively high temperatures—70 to 78 degrees Fahrenheit and a high monthly rainfall of 8 to 10 inches monthly. Some vegetables such as asparagus, turnip, squash, celery, Brussels sprouts, rhubarb and artichokes do best only at high altitudes.

CHAPTER 2

Vegetables For Tropical & Sup-Tropical Conditions

Without regard for cropping data, a list of commonly known vegetables that may be grown in the tropics follow:

Allium cepa— Onion (green)

Allium pavum — Leek

Asparagus officinalis— Asparagus

Basella alba— Spinach New Zealand

Beta vulgaris— Beet

Beta vulgaris cicla— Chard Swiss

Brassica juncea— Mustard

Brassica chinensis — Chinese Cabbage

Brassica Napobrassica — Rutabaga

Brassica oleracea —Broccoli

Brassica oleracea—Cabbage

Brassica oleracea— Brussels' Sprouts

Brassica oleracea borrytis— Cauliflower

Brassica oleracea var.— Collards

Brassica oleracea var.— Kohlrabi

Brassica Rapa— Turnip

Capsicum grossum— Pepper

Cichorium endivia— Endive

Citrullus vulgaris— Watermelon

Cucumis Melo— Melon

Cucumis sativus— Cucumber

Cucurbita maxima— Squash

Cucurbita pepo — Pumpkin

Cynara Scolymus — Artichoke

Daucos carota — Carrot

Hibiscus esculentus — Okra

Ipomoea Batatas — Sweet Potato

Lactuca sativa — Lettuce (leaf)

Lycopersicon esculentum — Tomato

Pastinaca sativa — Parsnip

Petroselinum crispum — Parsley

Phaseolus lunatus — Bean Lima

Phaseolus vulgaris — Bush Bean

Pisum sativum var. — Pea

Raphanus sativus — Radish

Rheum rhaponticum — Rhubarb

Sechium edule — Celery

Solanum melongena — Egg Plant

Solanum tuberosum — Potato

Vigna sinensis — Cow Pea

Zea Mays var. — Corn Sweet

Vegetables For Humid Tropics

In Burma and similar latitudes there is a wide variety of vegetables which are commonly known and

which should be listed. These vegetables, though not commonly known in temperate zones, are widely known in all tropical areas. Some of the more commonly known follow:

Allium ascalonicum

Amaranthus caudatus — Substitute for spinach

Amorphophallus campanulatus–Elephant's Foot (corm)

Benincasa cerifera

Cajanus Cajan — Pigeon Pea

Canna edulis — Tous-les-mois

Cicer arietinum — Garbanzo

Colocasia esculenta — Taro — Elephant's Ear

Colocasia antiquorum — Dasheen root

Coleus dysentericus — Madagascar Potato

Corchorus olitorius — Jute, Boiled green

Cucumis melo — Melon

Curcuma domestica — Turmeric

Dioscorea alata — Large white tuber

Dioscorea esculenta — Small White Rhizomes

Dioscorea cayenensis — Yellow meated rhizomes

Dolichos lablab — Hyacinth bean

Glycine max — Soy bean

Hibiscus cannabinus or *esculentus* — Kenaf

Lagunaria vulgaris — Bottle Gourd

Manihot utilissima — Cassava or Tapioca

Maranta arundinacea — Root

Pachyrhizus erosus — Potato Bean

Phaseolus aureus — Indian green garbanzo

Psophocarpus tetragonolobus — Goa Bean (edible pods & nuts)

Solanum macrocarpon — Pot Herb

Talinum triangulare — Substitute for spinach

To avoid confusion and to give the cultural information most needed in a condensed form the table shown in Part I Chapter I has been devised. Not all crops have been included but enough of them appear in the table to permit the reader to adapt those not included to those of similarity which are shown.

PART V

HORTICULTURAL CROP PRODUCTION

CHAPTER 1

Tree, Fruit & Nut Crops

This book deals with some fruit and nut trees which are readily used and found in the Tropics. No attempt will be made to cover the entire field of tropical horticulture since this broad subject is adequately handled by numerous books and encyclopedias. It is intended that enough information be given in this chapter on tree produced edible fruits and nuts to be useful as a guide to professional and amateur horticulturists in their day by day operations and in the selection of planting material.

Since fruits and nuts are often high in essential vitamins and minerals and make a pleasant addition to the daily diet, an attempt should be made to choose and select trees for their ability to furnish a succession of fruits throughout the year as well as for their immediate food value. To assist toward this end, the Puerto Rican Agricultural Experiment Station has cataloged the more important fruits and nuts according to the maturation season. Since Puerto Rico falls in the same general latitude as Pegu State in the Union of Burma (between 18 and 20 degrees N) the major fruit and nut crops shown in the table of Part I Chapter 1 should find a place well north or south of this zone.

Nut Trees

Since it would not be practical in this kind of handbook to treat each species separately, a system

has been selected which will treat each fruit in the genera to which it belongs. Under each genera one or two species will be discussed and the most important fruits and nuts within the family will be listed. Following are some of the more important tree plants which produce edible nuts:

Anacardium occidentale — Cashew nut — tree grows rapidly 20 ft to 40 ft—nut which is kidney shaped is borne at the base of the cashew apple—a bright yellow or red—native of Brazil—found throughout tropical regions of the world—grows on wide range of soils and is tolerant of drouth—propagate from seed—plant bears fruit in 2 to 3 years—fruit matures in 3 months—cashew nut is roasted before eating—high in fat and protein—the true fruit is edible fresh and the juice is used in beverages.

Artocarpus communis—Bread nut—tree 30 to 60 ft—prolific seed bearing—seeds 1 inch in diameter—tree grows rapidly—seedless variety available—many varieties—ovoid fruit 2 to 10 lbs—originated in Malaysia—grown in most tropical areas—brought to West Indies in 1792—fruiting more prolific in humid area but tree withstands normal drouth of several months—propagate fresh seeds or with root cuttings, suckers or layering. Seedlings will fruit in 3 to 4 years—seeds are edible after boiling or roasting and resemble chestnuts though less sweet.

Artocarpus integra — Jackfruit — close relative f the bread nut or fruit — leaves entire and 6 inch s long — fruit borne on brances along main trunk - fruit weigh 10 — 40 lbs — prefer humid climate and fertile moist soil — cultivated as a novelty in West Indies — propagate by fresh seeds — difficult to transplant — seedlings may fruit in 3 or 4 years —

pulp eaten raw or cooked — seeds similar to bread nuts.

Attalea funifera — Heavy pinnate palm with massive trunk — humid tropics — nuts 2 to 3 inches long with fibrous covering.

Bertholletia excelsa — Brazil nut — a very large forest tree of the Amazon region — humid tropics — nuts gathered wild since trees are not cultivated — globose woody fruit bears 12-24 angular nuts — propagation is by seed and tree requires from 15 to 20 years to mature — nut has a large demand and is of excellent flavor.

Canarium commune — Java almond — large tree, trunk butressed having laterally compressed surface roots — clusters of plum-like fruits with edible seeds — year round production — native to Malaya — humid tropics — propagate from seed — requires well drained soil — nuts edible in raw state — yield an excellent cooking oil.

Caryocar nuciferum — Butternut — lofty tree 80 to 100 ft — bears large woody fruit the size of a coconut — very hard shell — several edible species — native to Guiana — humid tropics — propagate from seed — may bear fruit six years from planting — kernels eaten raw — used in confection.

Cocos nucifera — Coconut palm — reaches a height of 60 to 80 ft — yield 50 to 75 nuts per year—many different species — a few are dwarf varieties — slow maturing — of Asiatic origin — tolerant of salinity and sand — grown on seashore in humid tropics — plant natural fallen nuts in nursery 3 ft x 3 ft—after germination (3 months) plant 3 leaf plant, spacing 30 ft x 30 ft — bear half crops on sixth year and in

prime at 20 to 40 years. Delicious eaten fresh but primary use is for oil which occurs in the meat — dried coconut copra is shredded and sold. The husk of the coconut furnishes "coir" fiber for making mats.

Cola acuminata — Cola nut — medium sized tree, long leaved — fruit is folicle and corky — seed angular — many species — native to West Africa — tropical climate — slow growers propagated from seed or cuttings — bear in 7 to 10 years — nut is chewed for caffein effect.

Durio zibethinus — Durian — Tall tree up to 100 ft — leaves 6" to 8", shiny dark green above and yellow underneath — fruit ovoid 6 x 12 inches — buttery whitish pulp — strong rotten onion smell — originated in Malaysian countries — humid tropics — propagated from seed — pulp is delicious but offensive odor — seeds are roasted or fried.

Juglans spp. — Vary in adaptation — a species of black walnut, a non-decidious evergreen to be found in the tropics of Peru, and the Persian or English walnut is found in Southern Europe and Asia. The tree is not well known in tropical areas but may be potentially valuable.

Lecythis elliptica — Small tree fruiting at 6 ft — 8 nuts borne in 3 inch diameter capsule — nuts 1¼ inches — chestnut brown — not well known — humid tropics — easily propagated from seed — nuts eaten raw — delicious flavor and very high in oil.

Lecythis zabucajo — Paradise nut — Monky nut — large forest tree — large woody capsule 8" x 10" bears 8 to 10 nuts similar to Brazil nut about 2 inches long — originated in Brazil — humid tropics — pro-

pagated by seeds and takes about 10 to 15 years to bear — excellent flavored nut — perhaps finest nut grown.

Macadamia spp. — Queensland nut — large evergreen tree 50 to 60 feet — fleshy husk bearing seeds ½ inch in diameter — Eastern Australia but extended to Hawaii and elsewhere. Rain forest — tropic temperate zone — propagate from cuttings — tongue grafts — seedlings variable when propagated by seed — eat raw or cook in oil — delicious — seeds are 78% fat.

Pistacia spp. — Same family as cashew nut — tropical evergreen but may be decidious — any climate suitable to live — plant trees 25 feet apart, one male to six females — propagated by seeds, budding and grafting.

Sterculia foetida — Java olive — large spreading decidious tree — flowers have a putrid aroma — fruit 4" with 10 to 15 seeds one inch long — originated in Asiatic Tropics — humid tropics — propagate by seeds — seeds eaten raw, roasted or fried.

Terminalia catappa. — Tropical almond — large spreading tree — 2 crops of fruit each year — ovoid fruit bearing one kernel 2 inches in length — malodorous flowers — nuts difficult to crack — originated in Malaysia — humid tropics — propagation is by seed — seeds are edible raw or roasted.

Important Tropical Tree Fruits Edible In The Fresh State

Following is a selected list of tropical tree fruits (to be eaten fresh) which are worthy of consideration either for home use or for local consumption.

Unfortunately most of these fruits are so tender and juicy that they are poor keepers and hence are of little value for export as in the case of the nut crops. The better known fruits such as pineapple, banana, citrus, etc. will be treated separately as commercial crops.

Annona . spp. — Cherimoya — Custard apple — several species (more than 50) 25 and less — bears at 5 years — fruit heart shape — one of best tropical fruits is *Cherimoya*—native to tropical America, Peru and Ecuador — essentially sub-tropical but does grow in humid tropics — species *diversifolia* is best for humid tropics. Propagated by seed — eaten fresh with custard-like flavor.

Calocarpum sapota — Namey — sapote — large erect tree — may reach 80' — reddish granular flesh — native of Central America — Humid Tropics — heavy soil — bears in 5 years from seed — very short viability — eaten out of hand and used as sherbert and preserves.

Carissa edulis — Evergreen shrub — globose fruit ½ inch in diameter — many species such as the Natal Plum, Christ Thorns, etc. — native to tropical Africa — humid tropics — propagate by seeds — fresh fruit or jelly.

Chrysophyllum cainito — Star apple — evergreen 50 ft — globose fruit 4' in diameter — purplish color — native to Central America — humid tropics — requires well drained soil — propagated by seed and budding — eat sweet edible pulp.

Coccoloba uvifera — Sea grape — low shrup or small spreading tree — 40 to 50 fruits borne in a cluster — hanging raceme — fruit globose and purple in color

—sandy seashore of Tropical America — tropical — low seashore — propagate from seeds or cuttings from ripe wood — eaten fresh or used in jelly.

Casimiroa edulis — White Sapote — spreading evergreen — 40 ft—3 inch ovoid fruit — creamy yellow flesh melting and juicy — several named varieties — native of Mexico — sub-tropical — 2,000 to 7,000 ft in tropics — propagate from seed — 8 years to bearing — best to use shield-bud known var. — eaten as fresh fruit.

Durio zibethinus — Durian — height of 100 ft — ovoid fruit 12 in. long covered with pyramidal spines — large seeds in with pulp — has rotten onion odor — Malaya is the origin — humid tropics — propagate from seeds and budding — pulp eaten fresh — delicious sweet flavor — seeds roasted.

Diospyros discolor — Velvet apple — medium to large evergreen — fruit 3 in. diameter — globose fruit develops usually without seed — 50 ft — mealy flesh — native to Malaya — humid tropics — grown from seeds — eaten fresh.

Eriobotrya japonica — Loquat — Nispero de Espana — Evergreen tree — highly ornamental — tree covered with grey down — pear-shaped fruit 2 to 3 in. long — yellowish flesh — over 800 varieties in Japan — native to China — needs altitude of 1,500 to 6,000 ft — needs cross fertilization — plant several trees — propagate by seed and budding — eaten fresh or stewed.

Ficus carica — Fig — Shrub or low tree — decidious — 2 fruit settings fall and spring — fruit soft and pear shaped — native to Asia Minor — grows in sub-tropic and tropical climate — withstands poor soil and drainage — best at higher altitudes — pro-

pagate by cuttings — consumed fresh or dry. Yield 2000 lbs per acre — plant 13 ft x 15 ft.

Garcinia mangostana — Mangosteen — slow growing evergreen 30 ft — sub-globose fruit 1 to 3 in. diameter — tree matures 10 to 15 years — comes from Asiatic tropics (Malay Peninsula) — humid tropics — needs clay loam soil with good drainage — propagated from seeds — short viability — an excellent fruit universally liked — eaten fresh.

Garcinia livingstonei — Imbe — Trees 15 to 20 ft — fruit bright orange color, 2 in. diameter — acid sweet watery pulp — native to Portuguese East Africa — edible plum-like fruit — needs no cooking.

Lucuma nervosa — Eggfruit — small tree 15 to 20 ft — globose orange colored fruit 2" to 5" long — native to Northern South America — humid tropics — propagate from seed — budding — eaten fresh — excellent in fresh or cooked desserts.

Mammea americana — Mamey apple — evergreen tree 30 ft to 60 ft — fruit ovoid 3-8' — sap has insecticidal properties — native to Tropical America and West Indies — humid tropics — propagated by seeds — pulp eaten raw — excellent in pastry and jams.

Morus alba — White Mulberry — Fruits similar to black berry — native to China — withstands drouth — sub-tropical — plant male and female trees — propagate from seeds or cuttings.

Parmentiera edulis — Tree 30 ft — Fruit 4" to 6" long, sweet and edible — native to Guatemala and Mexico — high rain forest — propagate from seeds — eaten fresh

Psidium guajava — Guava — low growing tree 6 ft to 25 ft — globular to pear-shaped fruit — origin

American Tropics—humid tropics—tolerates poor soil—grown from seed—grafts or air layers—bears fruit in 2 years—eaten as fresh fruit, juice or preserves.

Punica granatum—Pomegranate—Tree 15 ft to 20 ft—globular fruit with sweet pink juicy seed pulp—originated in southern Asia—Tropical to sub-tropical—propagate by seed, cuttings or layers—eaten raw or as cooling drink.

Spondias spp.— Several species not all edible—the hog plum is a tree up to 60 ft—fruit oval 1" diameter—origin tropical America—humid tropics—propagate from seed and cuttings—eaten fresh but usually infested with fruitfly larvae.

Tamarindus indica—Tamarind—Large, slow-growing leguminous tree—fruit is a straight brown pod 2 to 6 inches—acid pulp—native to Tropical Africa—humid tropics—withstands drouth but must have well drained soil—propagate from seed—eat the pulp or make a refreshing drink.

Zizyphus mauritiana — Indian Jujube—tree 10 ft to 40 ft—brown fruit one inch in diameter—edible acid pulp surrounds central stone—Asiatic Tropics is the origin—tropical climate—propagate by seeds, layering and grafting — eaten fresh or stewed.

Tropical Tree Fruits Which Require Processing

Antidesma bunius— Bignay — Malaya—Jams, Jelly, Wine.

Artocarpus spp.— Seedless breadfruit—boiled as vegetable.

Averrhoa bilimbi — Bilimbi—Indonesia—preserves.

Bixa orellana— Annatto—West Indies—food coloring.

Blighia sapida — Akee — Tropical Africa — Pulp cooked as vegetable.

Bromelia pinguin—Pinguin—Tropical America—acid beverage.

Brysonima spicata— Maricao—Tropical America—jelly & jam.

Chrysobalanus spp.— Cocoplum —Tropical Africa—Stewed—jelly & jam.

Cyphomandra betacea— Peru—Tree tomato—conserve.

Dillenia indica—Dilenia—Tropical Asia—stewed—conserve.

Dovyalis caffra— Kei apple— South Africa — jam & jelly.

Dovyalis hebecarpa—Ceylon Gooseberry—Ceylon—conserve.

Elaeagnus philippensis— Lingaro —Tropical Asia—jelly.

Eugenia jambos— Rose apple — East Indies — jelly & jam

Flacourtia spp.— Tropical Africa & Asia —preserves & jam.

Genipa americana— West Indies—beverage—jelly.

Grewia asiatica— Phalsa—India—beverage—jam.

Guilielma gasipaes—Tropical America—Peach Palm —boil or roast.

Inga laurina —Guama — Tropical America —dry pulp.

Lansium domesticum— Langsat—Malay Peninsula—preserves.

Malacantha spp.— Gold Coast—beverage.

Malpighia punicifolia— West Indian cherry—juice.

Meliccoca bijuga— Spanish lime—tropical America—jelly.

Muntingia calabura— Panama berry—jam.

Nephelium lappaceum— Rambutan—Malayan jelly.

Phyllanthus spp. —Grosella — Madagascar — Preserves.

Triphasia trifolia— Lime berry—tropical Asia—Candied fruit.

Uvaria lancifolia— Calabao—Asia—preserves.

Important Commercial Tropical Edible Fruits

Ananas sativus — Pineapple — stemless perennial — valued for fruit and fiber — takes first place among all purely tropical fruits — spiny leaves which bear useable fibers — fruit is enlargement of central stem — native to Tropical America — thrive from sea level to 3,000 ft — tropical but suited to dry climate as well as moist— reproduces by suckers or ratoons — land must be well drained — plant offsets or slips 3 x 2 ft — produces fruit 18 months from setting of sucker — crown plantings require 2 years to mature — to be eaten fresh or canned fresh—worldwide demand.

Carica papaya — Papaya — fast becoming a popular fruit — tree is herbaceous 6 to 10 ft and lives up to 4 or 5 years — plants are male and female — plant from seed and space 8 ft x 8 ft — plant bears 50 fruit per year — fruit is not only edible but plant may be tapped for its latex which is the main commercial

source — papain "meat tenderizer". This plant might well be classed with miscellaneous fruit trees.

Citrus spp. — Fall in 9 groups or species:

1. *Citrus sinensis* — Sweet orange
2. *Citrus paradisi* — Grape fruit
3. *Citrus limonia* — Lemon
4. *Citrus aurantifolia* — Lime
5. *Citrus maxima* — Pumelo
6. *Citrus nobilis* — Tangerine
7. *Citrus aurantium* — Sour orange
8. *Citrus medica* — Citron
9. *Fortunella spp.* — Kumquat

Small evergreen spiny tree, leaves aromatic—blossoms very fragrant—originated in Asia—Tropic and sub-tropical—requires medium textured soil well drained—very sensitive to lack of minor elements such as zinc, boron, copper, magnesium, etc.—propagated by seeds and grafting or seedlings one year old—replant after 6 to 8 months—set plants of approximately 20 ft x 20 ft (Limes 15 ft x 15 ft)—eaten fresh—worldwide importance.

Musa sapientum — Banana—Ginger family—quick-growing tree 10 to 15 ft—herbaceous stem composed of sheathing leafstocks—bears male and female flowers on same flower stock—fruits year around—most prolific of all foodcrops—does not bear seed—worldwide importance—hot humid climate—deep rich soils—propagate by suckers 12 ft x 12 ft—300 to the acre—bears in 12 to 15 months—manure treatment gives good results—yield 300 to 400 stems containing 10 hands to the bunch and each hand 12 to 16 fingers—eaten as a fresh fruit.

Musa paradisiaca — Plantain —same as banana only grown for starchy fruit. Must be cooked — grown throughout the tropics — yield is 4 to 6 tons per acre — culture is similar to that for bananas.

Persea gratissima — Avocado — Aguacate — small tree 25 to 30 ft — large green pear-shaped fruit — pulp of butter consistency — fruit 5 to 7 inches long — native to Tropical America — medium elevations in tropical or sub-tropical climate — propagate by seed, layering and grafting — a good tree bears 400. to 600 fruits — reaches bearing age in 3 to 5 years — eaten plain or as salad.

Phoenix dactylifera — Date Palm — a sub-tropical or arid tropic dioecious palm 60 to 80 ft — dates are staple article of diet in many countries and are known worldwide—origin probably in North Africa — requires great heat and dry atmosphere and irrigation — stands brackish salty soils of heavy texture — propagate by suckers — male and female trees — reach bearing age in 5 years — can be grown from seed — plant 58 to 60 trees per acre — 28' x 28' — yield is 100 lbs per year — productions to 80 years of age — edible in fresh or airdry state.

Ficus carica — Fig — See Tree. Fruits edible in the fresh state.

CHAPTER 2

Beverage Crops

Camellia Thea— Tea—variety Virdis from India and variety Bohea from China—a tree of 40 ft but pruned to a bush of 2 to 3 ft—has long tap root—needs abundant rainfall—grows from sea level to 6,000 ft—prefers acid soil—sow seed in nursery—set in field 4 x 4 ft at 10 months—top at 8 months to 1½ ft to cause bushing—first crop at 3 years—pluck once every 2 or 3 weeks—nip bud including first two leaves—yield up to 1,000 lbs per acre. Other genera producing a tea-like beverage are:-

Angraecum fragrans — Foam tea

Cassia auriculata — Matara tea

Catha edulis — Arabian tea

Eupatorium ayapana — Ayapana tea

Psoralea glandulosa — Jesuit's tea

Coffea spp. — Coffee — Several species, of which arabica furnishes the bulk of the world's coffee — small slender tree — native to Abyssinia — humid tropics — *arabica* prefers altitudes of 1,500 to 5,000 ft — robusta lower elevations — needs deep friable soil — liberica — 2,000 ft — sow seed in nursery — transplant 10 months from seed, placing 7 ft x 7 ft for arabica and 10 x 10 ft for liberica and robusta — give shade until established and even through maturity if desired. Top plant to 2' when they reach 4

to form spreading bush — plant matures at 3 years — yields 600 or 700 lbs per acre of dry beans.

Theobroma cacao — Coco — small tree 12 to 18 ft — bears fruit on trunks and stem — fruit pod contains 25 to 36 large seeds from which coco is made — native to Tropical America — Humid Tropics — must be grown in heavy shade — grows up to elevation of 2,000 ft — start plants from seed in nursery — transplant at end of 4 months at distances of 15 ft x 15 ft (200 trees per acre) — avoid excessive pruning — fruit ripen 5 to 6 months from flower.

CHAPTER 3

Vegetable Oil-Producing Tree Crops

Aleurites spp.— Tungoil—a small tree—native to China—moderate rainfall—sub-tropical—slow to germinate, 3 to 4 months—transplant direct 10 ft x 10 ft—yield 150 lbs nuts per year—yields drying oil.

Butyrospermum Parkii— Sheabutter grown in East Africa—medium sized tree yielding nuts with edible oil—grown from seed—slow grower—wild tree not cultivated.

Cocos nucifera— (See Nut Crops).

Elaeis guineensis — Palm oil—palm tree reaching 60 ft—palm is monoecious—native to West Africa—low humid tropics—plant fresh seeds—5 months to germinate—transplant seedlings at 8 months—space 26 x 26 ft—mature at 6 years—yield 4 tons of fruit per acre—yields oilnuts and palm toddy.

Ricinus communis— Castor oil—a tall quick-growing perennial, small tree—naturalized in Ceylon—sub-tropical to tropical — sow 10 lbs per acre spaced 6 x 6 ft—3 seeds to the hill—thin to 1 stalk—top at 3 ft—maturity date 4 months—yield 1,400 lbs per acre. Other genera of oil-bearing trees

of interest but no commercial value beyond local use follow:

Amoora Rohituka—

Agrania Sidiroxylon— Argan oil

Attalea Cohune— Cohune nut (like small coconut).

Bassia butyracea— Indian butter tree—several spp.

Dumoria Heckeli— Bako nut—Tree 150 ft high.

Taraktogenos Kurzii— Kalaw—North of Burma.

Many other trees.

CHAPTER 4

Latex-Producing Trees & Shrubs

Achras Sapota — Chickle — native to Central America — tropical — used in chewing gum manufacture. Not cultivated.

Dyera spp. — A large erect tree of Borneo in swampy areas — Latex is used for rubber and chickle. Not cultivated.

Heva brasiliensis — Rubber — quick-growing tall erect tree — native to Brazil — humid tropics — no less than 80 inches of rain — plant seed in nursery and transplant at 2 to 3 months or graft on seedlings. May plant seed direct — space 20 x 20 feet — trees may be tapped in 5 to 6 years — tap for 11 months every third day — rest period one month. Plant only high yielding clones.

Other interesting latex producers of no commercial value except in war periods are:

Castilloa elastica — Panama rubber.

Manihot glazivoii — Manicoba.

Funtumia elastica — Lagos rubber.

Landolphia spp. — Zanzibar rubber.

Palaquium spp. — Guttapercha.

Ficus vogelii — West African rubber.

Sapium jenmani — British Guiana rubber.

Urceola elastica — Burma rubber.

CHAPTER 5

Miscellaneous Horticultural Crops

In this miscellaneous grouping of plants there are included only those of commercial interest and a few are mentioned which may be of general interest. The plants are listed in use groups and may or may not be grown to the best interest of mankind, i.e. certain drugs. Many of the familiar seasoning herbs and spices commonly used are not listed because they are not native to the tropics nor do they do well as introduced plants without first finding suitable sites, such as hill gardens in the tropics.

Drug Plants

Aralia quinquefolia— Ginseng—a small herbaceous plant with fleshy roots—native of China—sub-tropical to temperate—rich friable soil—requires shade and moderate moisture—root is used as a stimulant.

Cannabis sativa— Hashish—Marijuana -a dioecious annual plant 4 to 6 ft—yields a narcotic and fiber—leaves are smoked for sedative or hypnotic effect—grows wild in sub-tropics.

Cinchona spp.— Quinine bark—small erect tree 25 to 40 ft—native South America—humid sub-tropics —rich humid soil with good drainage—high rainfall 100 inches plus—propagate by cuttings, layering or seed—mature in 6 years—drug quinine obtained from bark cut from branches.

Derris elliptica— Cube—rotenone—a large tuberous rooted climber—native of Malaya—humid tropics—plant tuberous roots 4' x 4'—powdered roots serve as powerful insecticide and as fish poison.

Erythroxylon coca —Cocaine plant—small shrub 6 ft—native to Peru—cool humid climate, 1,000 ft to 5,000 ft medium rich soil—plant 4 ft x 5 ft—propagate from seed—cocaine extracted from the leaves—leaves are often chewed with lime.

Papaver somniferum— Opium poppy—an annual herb—native to India and China—planted by seed 9 in. x 24 in.—matures in 3 months—yield 20 lbs per acre—extract latex from green pod.

Strychnos Nux-vomica —Strychrine—a medium-sized tree—native to Far East—forests of the dry region —not cultivated—flat grey seeds contain the poison.

Other Drug & Medicinal Plants

Abrus precatorius— Juice of this slender perennial climber is used to poison arrows. Often used in killing cattle.

Areca cathechu— Betel nut—tall slender erect palm —seed used as stimulating masticatory.

Cephaelis spp.— Emetic—specific for amoebic dysentery.

Codiaeum Tiglium—Croton oil—powerful purgative.

Cola acuminata— Cola nut on African tree—seeds contain 2% caffein — used in beverages and chewed.

Jateorhiza palmata — Calumba, tuberous roots — astringent.

Lonchocarpus spp. — Active ingredient "Rotenone".

Mentha piperita — Peppermint oil.

Piper Betle — Betel leaf — leaf chewed with betel nut — a perennial evergreen climber.

Piper cubeba — cubebs — widely used as a stomach tranquilizer.

Plumbago zeylanica — Elanitul — an ornamental— acrid poisonous roots — often used as a poison.

Smilax officinalis — Sarsaparilla.

Strychnos spp. — Curare — South American arrow poison.

Tephrosia bogelii — Barbasco — active ingredient "Rotenone".

Essential Oils

This group of plants usually produce a volatile oil upon distillation These oils are used in medicine, flavoring, insecticides, scents for perfumes, etc. A few of the more important are mentioned here although they have limited use in commerce.

Chenopodium ambrosoides — Worm seed oil.

Cinnamomum Camphora — Camphor.

Citrus spp. — Oil of lime, oil of lemon, etc.

Cymbopogon Nardus & spp. — Citronella oil.

Cymbopogon citratus — Lemon grass oil.

Eucalyptus globulus — Eucalyptus oil.

Eugenia caryophyllata — Clove oil.

Illicium anisatum — Anise oil.

Mentha piperita — Peppermint.

Ocimum Basilicum — Basil oil.

Pimenta acris — Bay oil — Bay rum.

Sanatalum album — Sandalwood oil.

Not mentioned here is a large group of flowers such as verbena, rose, tuberose, lavender, etc.

Waxes & Gums

Acacia senegalensis — Gum arabic.

Achras Sapota — Chickle gum.

Aquilaria Agallocha — Aloes wood, fragrant resin.

Ceroxylon andicola — Wax palm.

Copernicia cerifera — Carnauba wax or wax palm.

Euphorbia antisiphyllitica — Candelilla wax.

Garcinia Hanburyi — Gamboge.

Dyes

Bixa Orellana — Annatto dye (crimson)

Caesalpinia Sappan — Sappanwood (red dye)

Crocus sativus — Saffron dye (orange)

Haematoxylon compechionum — Purple dye

Indigofera arrecta — Indigo dye (blue)

Tans

Acacia arabica & spp. — Acacia.

Caesalpinia coriaria — Divi Divi.

Schinopsis Lorentzii — Quebracho

Uncaria Gambier — Gambir

Spices & Seasoning Herbs

Allium sativum — Garlic — a bulbous plant with flat leaves — propagated from bulb sections set 7 x 7 inches apart.

Brassica spp. — Mustard is made from the seed — an annual 2 ft to 3 ft — a poor soil plant.

Cinnamomum zeylanicum — Cinnamon — moderate to large tree 40 ft to 60 ft, native to Ceylon and India — tree is grown as a bush — seed sown in place 10 x 10 ft — harvest consists of removing bark from young shoots 8 ft long—2 years from sowing.

Curcuma domestica — Turmeric (See Root Crops)

Elettaria cardamomum — Cardamom — Tall herbaceous perennial 8 ft with creeping rhizomes — native to Ceylon — grown for the aromatic seed — sown from rhizome 10 ft x 10 ft — yield 150 lbs per acre.

Eugenia caryophyllata — Clove — Small tree 20 ft to 30 ft conical in shape—native to Moluccas—Cloves are the dry unexpanded flower bud — propagated by seed — does well up to 2,000 ft — seedlings planted 20 ft x 20 ft when 12 inches high — mature in 8 years — harvest is 8 to 10 lbs per tree or about 800 lbs per acre.

Illicium verum — Anise — Shrub or small tree native to South China — the fruit is used as a spice and the oil from leaves is used to flavor liqueurs — grown from seed set 6 ft x 6 ft.

Myristica fragrans— Nutmeg —a large dioecious tree 60 ft—75 ft tall—plant seedlings 36 ft x 36 ft with one male tree for every 12 females. Trees bear in 9 years — each tree will yield 3,000 to 4,000 nuts.

Ocimum Basilicum — a small herbaceous plant grown from seed planted 2 x 6 feet. The leaves are dried and used as a condiment.

Pimenta officinalis — Allspice — a small tree with smooth greenish bark 25 to 30 ft high. Bears fruit the size of a pea. Several different genera which bear similar fruit and have the same common name .... the species *acris* is the Bay berry — native to West Indies—tropical—transplant seedlings 10 ft x 10 ft— trees mature in 10 to 18 years — yield 100 lbs of berries per acre.

Piper nigrum — Pepper — a creeping perennial vine — low humid tropics — grown on supports — plants grown from cuttings and set 7 ft x 7 ft apart—mature in 3 years — yield 1,000 lbs of dry fruit per acre.

Vanilla planifolia — Vanilla — vine of the orchid family—a tropical shade-loving plant—grown from cuttings 6 ft x 6 ft apart — plants fruit in 18 months after artificial pollination — yield is 150 lbs of dry beans per acre.

Zinziber officinale —Ginger — herbaceous perennial native to tropical Asia — underground tuberous stems (rhizomes) yield the ginger of commerce— requires hot moist climate — plant tubers 18 x 12 inches apart—harvest in 9 months — yield 1,500 lbs per acre.

PART VI

THE PROCESSING AND PRESERVATION

OF

AGRICULTURAL PRODUCTS ON THE FARM

CHAPTER I

The Processing and Preservation of Agricultural Products on the Farm

Milk

Of all the home processing procedures, the preservation of milk and milk products is perhaps the most important. Milk in its fluid form taken directly from the animal remains fresh and potable for only a few hours when stored above 50°F. At or below 50°F. fresh, clean milk will keep fresh for several days. The same milk, however, processed in its whole state or reduced to its various forms such as butter, cheese, powder etc. may be good and palatable for long periods of time. Even without processing, the usability of milk can be enhanced by clean handling of the fluid in sterilized equipment. Any equipment which has less than 5,000 bacteria per square foot of surface area may be considered sufficiently sterile. Thus a one paint milk bottle has an inside total surface of approximately 0.4 sqft and a quart bottle has approximately 1.6 sqft. In the latter case, if more than 8,000 bacteria would be present in the bottle it would not be sterile. To sterilize containers, 5 minutes of steam sterilization or 5 to 10 minutes in boiling water should suffice. Legal standard milk in most countries calls for a product with a minimum of 12% total solids and 3% fat with a combined weight value 10.3 pounds per gallon or 1.025 kilograms per liter.

Besides sterilization of the receptacles in which milk is handled, the product itself may be additionally preserved on the farm through (1) pasteurization, (2) sterilization or (3) boiling.

Pasteurization consists of killing the bacteria by raising the milk temperature to 145°F and holding at this temperature for 30 minutes.

Sterilization consists of heating the milk under 15 lbs steam pressure for 5 minutes.

Boiling— Boil the milk in an open container stirring constantly for 3 minutes at a rolling boil.

In all cases where milk is consumed without proof of its sanitary production, it should be pasteurized or boiled.

Butter — Butter is the fat separated from the cream of any milk by churning. The process follows:

1. Separate cream from the milk.
2. If milk was not pasteurized, pasteurize the cream.
3. Boil all utensils used in making the butter.
4. Bring cream to a constant temperature of 65°F. or reasonably cool.
5. Shake or churn cream until butter granules form and adhere in lumps.
6. Pour off the buttermilk and massage with a wooden paddle until moisture has been expelled. Add salt to taste, mold and store in a cool place. (If granules fail to form after 15 minutes of churning the temperature of the

cream is either too high or too low or the churning is too violent.)

To calculate the yield of butter from cream:

$$\frac{\text{Wt. of cream} \times \% \text{ fat in cream}}{100 - \% \text{ water in the fat}}$$

To calculate the yield of butter from milk:

The quantity of butter yield is approximately equivalent to the % of fat in the milk. Thus 100 lbs of 4% milk will yield about 4 pounds of butter:

Ghee — Ghee is clarified butter (butter oil) and can be made from any milk including that of the goat which does not have a natural separation of cream and milk on standing. Although Ghee can be made from pure butter it is best made by (1) boiling fresh cream continually until all water has evaporated and the proteins have coagulated. Ten gallons of milk (45 liters) with 4% cream or butter fat produces 3 lbs of ghee or 1.36 Kg. Filter completely, the butteroil from the curds otherwise the product will not keep.

Cheese— Cheese is a delicious product made from whole milk, cream enriched wholemilk, cream, or skimmed milk. It is a product of coagulation and the source of milk whether from sheep, goat, mare or cow determines the general kind of cheese to be produced. In general, cheese is made by adding a coagulating substance such as rennin (an enzyme) or by simply souring or fermenting the cream. When fully coagulated, the curdled milk is placed in a mold provided with drains which drain off the whey. After complete drainage the crude cheese is subjected to some pressure for several days and

is then stored in a cool place 60°–65°F. for several weeks or months to cure before eating.

Fruits and Vegetables

Drying surplus food in the season of plenty means food in the season of scarcity. Almost all fruits can be dried regardless of whether or not they are of firm flesh or juicy. Following is a list of the more common fruits and vegetables grown in the tropics which can be dried:

Fruits:

Coconuts, dates, figs, guaves, nectarines, apples, peaches, pears, avocado, berries, jujube, banana, breadfruit, mamey, and many others.

Vegetables:

Beans, peas, chillies, corn, potatoes, sweet potatoes, cassava root, onion, garlic, asparagus, beets, carrots, celery, greens, okra, peppers, pumpkin, squash, tomatoes and others.

Drying fruits and vegetables requires dry warm air with plenty of circulation around each piece of food being dried. These conditions will be found on sunny hot days when the air is dry and has some movement. When these conditions prevail, take the following steps: (1) Gather fruit or vegetables (2) Wash thoroughly (3) Peel and remove seeds where necessary (4) Slice into thin discs across the grain of the fruit (5) Spread slices evenly one layer in thickness on a slatted or coarse screen tray (6) Cover with loose weave netting or screen wire and place in direct sun to dry with complete circulation. (Put tray up on legs or blocks) (7) Turn slices two or three times daily (8) Test slices for dryness after

three or four days of drying (Squeeze a handful and if no moisture appears on the hand and if the slices spring apart when pressure is off (spongy feel), the fruit is dry.) (9) Store in a plastic bag or jar but stir daily for ten days. Jar must be moisture proof. Paper bags may be used also or cloth bags of tightly woven material, but in moist weather supplemental oven drying may be necessary. (10) After 10 days seal tightly and store.

The above directions are for vegetables as well as fruit except that vegetables should be steamed first. (Thinly sliced vegetables should be steamed for 5 minutes and 15 minutes for peas, corn, asparagus, etc.)

Steaming preserves vitamins, retains color and reduces drying time. To steam, merely place slices in a kettle on a screen several inches above a 2 inch layer of boiling water. Place the lid, bring to a continuous boil and steam the necessary time. Remove and place on drying trays.

Meat

Preserving meat as in the case for fruits and vegetables consists of putting it in a form which will prevent spoilage, thus prolonging the period of plenty and shortening the period of scarcity. There are in general four methods for preserving meat on the farm. These are:

1. Sun-drying
2. Dry salted
3. Smoked
4. Cured or Pickled

Sun dried: This process consists of cutting the meat in ¼ inch thick sheets and drying directly in the hot sun. It can be hung across a wire or laid on a wire tray the same as for fruit. All fat must be removed before drying and salt should be added to both sides of the meat. Meat should be turned daily until it is brittle enough to break or until it is hard and shows uniform color and texture throughout. Store in tight containers. It can be kept in this state for more than a year. It may be eaten in the dry state or boiled with vegetables, etc.

Dry salted: (1) Prepare as for sun drying, but soak in a saturated salt solution for one hour (2) spread in layers covering with 1 inch or more of salt. Re-layer and re-salt daily for five days. (3) Place meat between perforated boards and add enough weight to remove as much moisture as possible (4) Hang in the direct sun to dry (2 hours the first day, 4 hours the second and 6 hours the third day and then completely sun all day until meat is hard and dry). Store in tight containers and soak out salt in water before using.

Smoking: This process consists of cutting the meat in thin slices or removing the bone from large pieces such as hams, and curing with smoke. It should be thoroughly salted and hung in a tight shed with a smoke chamber below the floor. Hard-wood or cobs should be allowed to smoulder and smoke for about 3 days. The heat and the smoke cooks the meat. Large pieces such as hams require about a week of smoking at a temperature of 145°F.

Curing & Pickling: This process is one in which bacteria inhibiters are used, such as salt, sugar, vinegar or spices. Pickling and brining are the most

popular and consist of storing meat in a pickle consisting of 8 lbs of salt, 2 lbs of brown sugar, 2 ounces of saltpeter, 4 gallons of water. This is sufficient for 100 lbs of meat. Pickle penetration is at the rate of about ½ inch per week. When brine has completely penetrated the meat, store in wooden kegs or tubs and keep covered with brine or hang in a cool dry room.

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A Word of Counsel For The Tropical Agriculturist

This final word of advice is meant more for he who tills the soil than for he who dishes out technical advice to the farmer.

It is quite generally agreed that there is no more noble profession than the farming profession, and the honor attached to farming, rates among the highest. These are self-evident truths but it takes more than nobility and honor "to keep the baby in shoes". To stay in the game of farming one must first be endowed with brains and secondly with an undying love for the soil. A lack of either one results in subsistence farming, which in turn breeds poverty and misery. Perhaps this is the reason for the miserable state that tropical agriculture finds itself in today. In this day and age, there may be some excuse for not loving the soil, but there is no excuse for ignorance. As far as mentality is concerned all men, regardless of race, are equal, but they are not equal in the manner in which they use knowledge, accept challenges, or reach for opportunity.

Tropical agriculture is the easiest agriculture known. It is a lazy man's Utopia. It is the only

agriculture which involves essentially only the harvesting of the crop. Nature, with but little encouragement, takes care of all the rest. One can plow or not as he sees fit. He may prune or not prune. Clean cultivation is unknown and I might say impossible — he therefore merely slashes to keep down competition. Watering is taken care of from the sky and needs no tending. and the ever-troublesome act of planting is often solved by dropping a seed or a cutting and stepping out of the way. All this of course is over simplification and reason enough for neglecting the routines so necessary to good farming and maximum production. Even in the tropics there is a right and wrong way to do everything but unfortunately the great majority prefer the easy way and, as a result, we find on lands which should teem with abundance, nothing but stark poverty, malnutrition and misery.

The great cry coming from this wilderness today is for more and more technical knowhow and for the past fifteen years vast endeavor in this respect has been dissipated into the ever-devouring jungle with little or indifferent results. The time is at hand when the farmer will have to decide. Will he loll in the shade and hang on to his neglected 30 eggs a year hen, his 3 mangy pigs per litter sow and his one quart cow, his sour oranges and his tasteless vegetables? Or will he decide to expend a little energy and boost his egg production from 30 to 200 his pigs farrowed from 6 per year to 24 and his milk from a daily one quart to 12 quarts? His little corn field, which yields 10 bushels per acre will yield 100 bushels and it will be this corn, along with succulent pasture that will help make his meat and milk production a reality Mr. Farmer, it is up to you — you can be taught by

anyone but only you can learn, and only you can put into practice what you learn. If you like the squalor and the misery perpetuated by long endured false farming practices, there is not much more that need be said, but if you would like to change for a better life and have some prospects for a future, read and do, or just listen and do — nothing else is required. In this, your national, state and local governments are prepared to help you, not just today or tomorrow but now and forever.

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Reference Reading Review

Because of the nature of this handbook it seems highly desirable to include a few references, whereby the agriculturist can satisfy his needs or his curiosity for complete details. The foregoing manual was not designed to give detail but more as a temporary crutch to get the farmer from here to there without undue loss of time or effort.

There are available several very fine references which should be on the book shelves of every farmer who knows how to read or who just likes to look at pictures. Space does not permit the inclusion of all but some excellent samples follow. If the information contained in these few references was accepted and put into practice the world would see an agricultural abundance never before dreamed of as a possibility.

Useful Reference Books

Anonymous:

Handbook of Agriculture — Indian Council of Agriculture Research, New Delhi 1961 — Excellent

re iew of Indian Agriculture and a handy guide book for farmer and field worker.

Bailey L.H.:

Standard Cyclopedia of Horticulture — Published in 1914-17 — An outstanding work and a must for the professional.

Bailey L.H.:

Hortus — The Macmillan Co., New York — 1930-47 — A concise dictionary of Gardening and General Horticulture — a must for the professional and a useful tool for the trained amateur.

Burkhill I.H.:

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